Engineering News

Vol. 68, No. 12 505 Pearl Street, New York September 19, 1912

Locomotives with Five and Six Coupled Axles

A locomotive having six driving axles coupled together in one group has been built in Europe, although five axles is generally considered the maximum number that can be coupled together in one group. However, the new engine is for a narrow-gage line in Java, and its length of wheelbase is only about the same as that of some very much heavier recent American standard-gage engines having five coupled axles, as shown by the diagram, Fig. 1. These latter engines also can pass curves of 273 ft. radius, while the sharpest curves for the foreign engine are given as 460 ft., although probably this refers to curves on the open line and not at turnouts or yards. Some particulars of these two classes of engines are given below.

2:10:2 Locomotives; C., B. & Q. R.R.

Locomotives of the 2:10:2 type have been used for some years on the A., T. & S. F. Ry., and the largest of these (Engineering News, June 2, 1910) weigh 143 tons, with 117 tons on a driving wheelbase of 19 ft. 9 in. They are four-cylinder tandem compounds, having 57-in. driving wheels, and cylinders 19+32x22 in. The locomotives of this type which have been put in service recently on the Chicago, Burlington & Quincy R.R. are simple engines of considerably larger size; they weigh 190 tons, with 150 tons on a driving wheelbase of 20 ft. 9 in.; their driving wheels are 5 ft. diameter, and their cylinders are 30x32 in. The boiler is of the straight-top type, and the firebox has a combustion chamber projecting into the barrel and fitted with a firebrick bridge wall of the Gaines type. The special equipment includes fire-tube superheater, underfeed mechanical stoker, and power reversing gear (with Walschaerts valve motion). In the main (middle) driving wheels there is not room for the full amount of counterbalance in the wheel centers, and the excess amount is applied therefore as separate counterweights on arms keyed to the axle.

To permit of passing curves of 21° (273 ft. radius) the front and rear drivers have considerable lateral play; the clearance is 7/8 in. for these wheels and 5/8 in. for the second and fourth pair. The main (middle) drivers have blind tires. To give corresponding flexibility in the coupling rods, the stub ends of these have their knuckle pins fitted with spherical bushings of hard steel. One of these great engines is shown in Fig. 1. Five have been built by the Baldwin Locomotive Works, and their leading dimensions are given in the accompanying table.

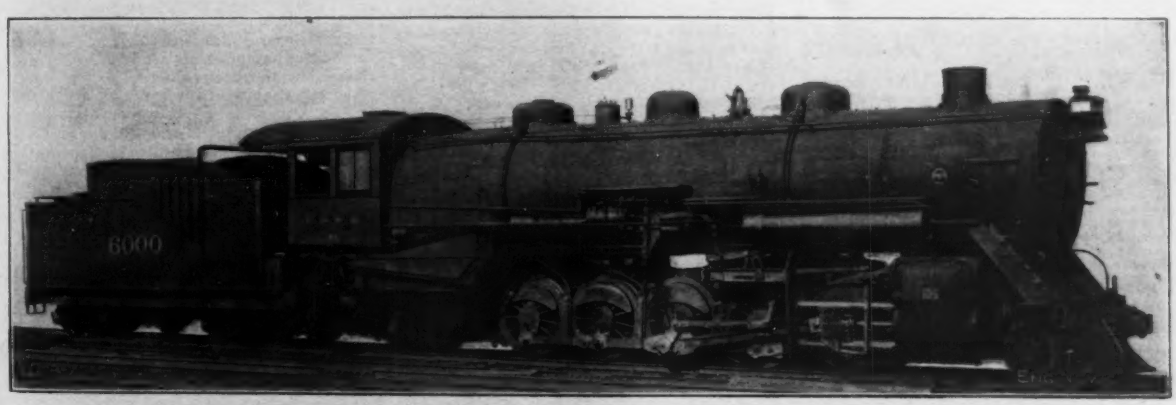


Fig. 1. Freight Locomotive of the 2:10:2 Class; Chicago, Burlington & Quincy R.R.

(F. A. Torrey, General Superintendent of Motive Power. Baldwin Locomotive Works, Builders.)

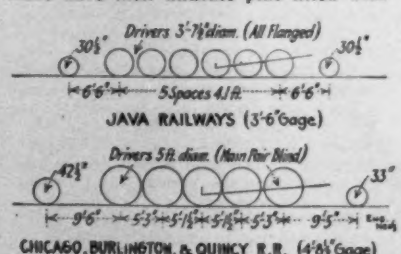


Fig. 2. Relative Wheelbase of Ten-Coupled and Twelve-Coupled Locomotives

2:12:2 Tank Locomotive for Java

The engine of this type, mentioned above and shown in Fig. 3, is for the Netherlands State Railways in Java, having a gage of 3 ft. 6 in. It is a tank engine, but instead of the usual arrangement of side tanks extending above the running board nearly to the level of the top of the boiler, the tank is of T-section placed between the frames (forward of the firebox) and extending outside of them. The top of the tank forms the running board. This arrangement enables the boiler to be set relatively high without raising the center of gravity of the engine, and it has the advantage that the sides of the firebox are not concealed by the tanks, so that the staybolts are open to inspection at all times. Further, the view of the engineman is not obstructed by the tanks.

All the driving wheels have flanged tires. The four middle axles have no lateral play, but the first and sixth axles have the Golsdorf system of lateral motion to facilitate the passage of curves, the sharpest radius being 460 ft. (presumably this does not apply to turnout curves). The trucks have radial axles of the Adams system. The boiler has iron tubes and a copper firebox; its equipment includes the Schmidt superheater, Mar-

cotty smoke-consumer and an adjustable exhaust nozzle.

The engine is fitted with the Hardy vacuum brake (and train brake), the Riggenbach steam brake for control on steep grades, central couplers (of the hook type commonly used on foreign narrow-gage railways), the Gresham steam sanding device, and the Haushalter speed indicator. This engine was built by the Hannoversche Maschinenbau Actien Gesellschaft, of Hanover, Germany, and the leading dimensions are given in the accompanying table.

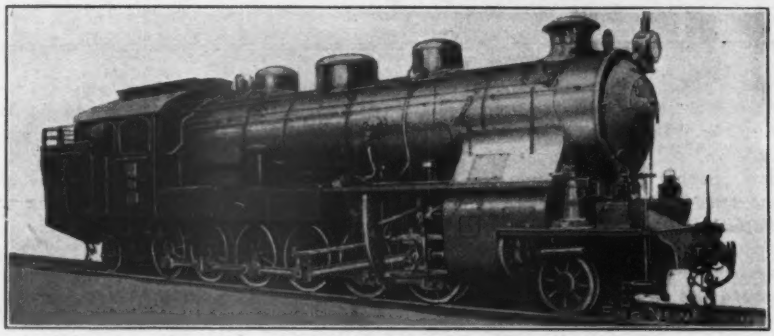


FIG. 3. LOCOMOTIVE OF THE 2:12:2 CLASS; NETHERLANDS STATE RAILWAYS IN JAVA

DIMENSIONS OF LOCOMOTIVES OF LONG WHEELBASE

Railway	C.,B.&Q. (U.S.A.)	Java
Gage	4 ft. 8½ in.	3 ft. 6 in.
Class of engine	2:10:2 (tender)	2:12:2 (tank)
Driving wheels	5 ft. 0 in.	3 ft. 7½ in.
Front truck wheels	2 ft. 9 in.	2 ft. 6½ in.
Rear truck wheels	3 ft. 6½ in.	2 ft. 6½ in.
Wheelbase, driving	20 ft. 9 in.	20 ft. 6 in.
Engine, total	39 ft. 8 in.	33 ft. 7½ in.
Engine and tender	74 ft. 4 in.	.....
First driv. axle to truck axle	9 ft. 5 in.	6 ft. 6 in.
Rear driv. axle to truck axle	9 ft. 6 in.	6 ft. 6 in.
Blind tires	middle (main)	none
Weight in working order: on drivers	301,800 lb.	125,700 lb.
On front truck	26,600 lb.	.....
On rear truck	50,300 lb.	.....
Engine, total	378,700 lb.	164,500 lb.
Engine and tender	562,000 lb.	.....
Cylinders	(2) 30x32 in.	(2) 21½x20½"
Boiler, diameter at front	7 ft. 4½ in.	.....
Height to c. line	.....	8 ft.
Firebox	11x8 ft.	.....
Tubes, No. (30 superheater)	285, 30	.....
Diameter	2¼ in., 6 in.	.....
Length	22 ft. 7½ in.	.....
Heating surface: tubes	4,841 sq.ft.	.....
Firebox and combus. chamber	320 sq.ft.	.....
Total	5161 sq.ft.	1800 s.qft.
Superheating surface	970 sq.ft.	390 sq.ft.
Grate area	88 sq.ft.	28 sq.ft.
Water, gal	10,000 (tender)	1870 (tank)
Coal, tons	15 (tender)	3 (bunker)
Tractive force	71,500 lb.	27,550 lb.

How Not to Introduce "Scientific Management"

A correspondent of London *Engineering* describes an experience in connection with the introduction of scientific management in an English factory which may convey some useful lessons to American engineers. We reprint the letter here as follows:

What many managers and their lesser satellites fail to understand is poor human nature. Were it a new problem, there might be some excuse for them; but, seeing that it is as ancient as man himself, excuse is impossible to the so-called "captains of industry" who fail in its study.

The writer has a modern factory in his mind that produces high-class work; it has borne a proud and honored name in the engineering world; and yet, among the men and staff, the place is talked about as being a veritable hell. Making due allowances for the vigor of the term, it is common knowledge, among those who know the factory in question, that a most unhappy state of affairs exists there. This, in the writer's opinion, is due entirely to the fact that the management—if ever it knew it—has lost the art of managing men, and, after all, that is the whole art of government.

The factory is run on the bonus system. This system was established after a disastrous strike, which might have been avoided had more tact and diplomacy been employed in introducing it. An otherwise kindly, but headstrong, superintendent, with a cast-iron system of management in his pocket, was installed, and without taking into consideration the fixed and settled habits of a generation, he commenced playing skittles with the growths and small institutions of the factory. Like the true skittle-player, the more pins he knocked down with every shot the happier he appeared to be.

He flooded the factory with paper. Forms for this and forms for that. All the colors of the rainbow were called into requisition to distinguish his particular whims. Foremen, who before the advent of this system had spent their days in and around the machines and various shops, discovered that more than a fair proportion of their time was required to fill in this, to answer that, and give reasons for so and so, and so on. Foremen who were too old to drop into the new ways, but who knew their old jobs in and out, were dismissed. Much of the work produced by the factory was tricky, and the vacuum caused by the loss of many of these foremen was not easily destroyed. Then, to run the bonus system, a new army of officials was called into being. Where or how they were got was a puzzle, for scarcely any of them came with a decent record as a workman. Men soon find these things out in engineering shops, for their societies have long and acute ears. Then commenced the trouble. Friction was soon set up. The men would not accept the bonus system, and eventually they struck work against it. After a time a kind of settlement was arrived at, and work resumed.

The system hardened; the speed and feed bosses were multiplied, and showers of paper—avalanches, in fact—still continued to fall upon the factory. The men, naturally, asked the questions, how were all these extra officials to be paid and who discharged the paper bill? However, to shorten the recital, this particular superintendent, who had many admirable qualities for management, left. To him succeeded an amiable but weaker man, though just as strongly imbued as his predecessor with the magic of "System." The more optimistic among the staff hoped for better times, and at least anticipated that they would be treated as responsible units of the factory. Alas for their hopes! Bundy clocks were stuck up that had to be punched at every starting and knocking-off time; childish lavatory regulations were imposed, and other petty annoyances inflicted calculated to wound the self respect of ordinary mortals. Truly, an Amurath to Amurath had succeeded. Under the new system, foremen found that their presence in the office was much more necessary than it was before, for each had, and still has, a periodical list of questions to answer, which if honestly performed, will take hours to do. In other words, the foremen—those that are left—are slowly being turned into paper men too.

With this, too, has been established a system of supervision. Each man is reported upon almost every day of his working life. And, what is worse than all, he sees the watchers being elevated into positions of trust for which they have no special natural or acquired ability.

This is the outcome of failing to study man. When will some employers learn their lesson? The factory in question has the most modern and beautiful machinery within its walls; it has, or had, a goodwill that was the envy of its rivals. It had a staff of picked men that knew their jobs through and through. This state of things is imperilled and runs the risk of deterioration, and on account of system gone mad.

Yes; let us have "motion study," more of it, and let us study man. But it must be done by men of sympathetic dispositions.

Shortage in Freight Car Supply and in locomotives may be due in some measure to unsystematic or inefficient methods for keeping track of equipment withdrawn from service for repairs or other purposes. This is the view expressed by the Illinois Railroad and Warehouse Commission in a statement issued recently. Referring to the shortage of cars and locomotives required for handling grain and coal during the fall and winter of 1911, the Commission states that its investigation showed that more or less of the equipment of the railways of Illinois is unfit for use. In many cases, large numbers of cars and locomotives were out of service. In some cases good reasons were given for this state of affairs; in many other cases no reason was given. But it is stated that traffic could have been taken care of much better if the railways had kept their equipment in proper repair and ready for use. The purpose of this statement is to inform the railways that indications point to a large crop this year, and that all equipment that can be used in this service should be put in order in readiness to handle the traffic. The railways are to report to the Commission by Nov. 1, the number of cars fit for handling grain and coal, and the number of cars and locomotives unfit for service.

Sixth Congress of the International Association for Testing Materials

[Concluded from Engineering News of Sept. 12, 1912, p. 507.]

Section A

Magnetic Properties

Five papers on magnetic properties of iron and steel were presented. C. W. Burrows (U. S.) reviewed the subject of the connection of magnetic and electric properties of materials with mechanical properties, with the main conclusion that certain magnetic and electric tests may supplement or even replace certain mechanical tests and that a close relation has been indicated between magnetic properties and the presence of flaws, blow-holes and strains in the metal. R. P. Devries (U. S.) gave the results of experiments in which tensile strength, Brinell hardness and magnetic properties were compared. It was found that in the Brinell test the depth of impression with increasing load gives a direct linear variation, and the tensile strength was found to be a linear function of the Brinell hardness. The magnetic results in a series of similar steels showed a general relation between magnetic and mechanical properties, though there are many discrepancies.

E. Heyn (Germany) in discussion noted that the proportionality of pressure and depth of indentation had been found some years ago by himself and Martens, but that the proportionality may fail at high load. Mr. Devries replied that his experiments covered very high loads and went considerably beyond the range covered by Heyn and Martens. The measure of depth is a better basis for calculation than measuring the diameter of indentation.

A paper by De Nolly and Veyret on the magnetic properties of dynamo sheets led to the general conclusions that the most desirable chemical composition of such sheets is: C less than 0.1%, Si 3 to 4%, Mn less than 0.3%, S and P less than 0.03%; that rolling should be carried to a low temperature; and that the sheets after rolling and after all cold-working should be annealed at about 800° C. and very slowly cooled.

In a paper from the laboratory of Schneider & Co. (France), presented by A. Saladin, the results of permeability tests on short and long bars and ring specimens of steel under various temperatures up to 850° C. were reported. The curves showed direct relation between the critical points of structural change and the permeability. The changes are abrupt in short bars, while in long bars the variation of magnetism extends over a much larger range of temperature. High hysteresis was found in a steel containing much oxygen (after-blown bessemer steel). P. Weiss (Switzerland) reported a study on the relation between the magnetic susceptibility and the constitution of metals of the alloys of iron and nickel, nickel and cobalt, and cobalt and iron. The results brought out clearly the eutectic alloys, and one of these alloys was found to have a saturation intensity 10% greater than that of pure iron at ordinary temperature.

Thermal Variation of Mechanical Properties

F. Robin (France) in two papers discussed the variation of mechanical properties of metals with temperature. The general phenomena for ferrous and non-ferrous metals were reviewed in one of these papers, while in the other the fact was noted that the ball test permits of measuring hardness at any temperature with equal facility; tests results on steel, cast iron, etc., are given.

A theoretical paper on the bursting strength of thick gun-tubes was presented by M. Malaval (France), who takes account of the stress-distributing effect of plastic strain.

Impact Testing

In some discussion of the subject of impact testing, which was omitted from the report in our last issue (p. 504), A. Denny (England) expressed disbelief of the present practical value of impact testing for reception purposes. Prof. W. C. Unwin (England) preferred larger test pieces than 10x10 mm. for practical use. Henry Souther (U. S. A.) brought out the importance of impact testing for automobile material but expressed the belief, that it is not yet available for everyday use. A. Mesnager (France) presented a resolution advocating for temporary adoption a height of fall of four meters, a testpiece 10x10 mm. with a rounded 2-mm. notch and an anvil 40 times heavier than the ram. Prof. E. Heyn (Germany) strongly opposed this resolution as being only tentative, not yet considered by the committee and disagreeing with the standards of the German Association for testing materials. The resolution adopted by the Congress was given in our last issue.

Steel Rails; Unsoundness and Cracks in Steel

O. Gallander (Sweden) described a method for measuring the depth of surface cracks in conducting metals. Four electric contact points, two transmitting a current and two for measuring potential difference, when placed in proper relation across a crack enable the depth of a crack to be determined by the galvanometer deflection.

Blowholes and cavities in steel ingots were discussed by J. E. Stead (England). His general conclusion is that the ordinary treatment to which ingots are exposed in heating and rolling suffices to weld up all small cavities or blowholes provided there are no (or only scattered) sulphide segregations; also that surface blowholes even if oxidized may become welded up if a high temperature is maintained long enough after closure of the cavities to permit the carbon of the steel to reduce the oxide. These conclusions are drawn from various past observations and several series of experiments made for the purpose of this particular investigation.

A new method of detecting surface cracks in steel rails was described by A. Mesnager (France). According to the author, transverse or polygonal cracks on the head of the rail frequently cause fracture. Such cracks are due to the cold-rolling of the wheels and to the heating effect caused by skidding wheels and the sudden chilling by the large mass of surrounding metal. Upon roughly polishing off a very thin film of metal and etching with weak acid, the cracks are revealed, and they may be made clearer either by treating with tannin and gallic acid to blacken the cracks, or by rubbing in printer's ink, wiping off, and printing off with a piece of paper.

The American steel-rail situation was the subject of five papers. J. P. Snow (U. S.) discussed briefly the consecutive developments in the rail situation beginning with the introduction of steel to replace wrought iron, and the subsequent standardization of rail sections in 1893. He referred to the various expert investigations of the rail question now in progress and to the complexity of steel manufacture, and stated that a single cure for bad rails is not to be looked for but that the remedy must lie in improving rail-production processes in every stage. J. E. Howard (U. S.) referred particularly to the complex stresses to which rails are exposed in service, and emphasized the need of determining by study and experiment the fiber-stresses which are set up in the metal in service in tracks. He recommended that after such determination and after a study of the physical actions in the track, tests should be developed directly for those qualities which are brought into service. P. H. Dudley (U. S.) described the method of test used on the New York Central Lines, where, in the ordinary drop-test of the rail, the elongation at the bend is measured and thus the ductility of the metal is indicated. This method can be so applied as to give a very prompt and close check on mill practice, and it has been found possible to improve the working conditions in furnace and rolling-mill according to the indications of this test, in such measure that mills which at first could not regularly produce satisfactory rails soon succeeded in meeting all requirements with great regularity. M. H.

Wickhorst (U. S.) reviewed briefly the investigations now being conducted on the part of a committee of the American Railway Engineering Association at the direction of the American Railway Association, to determine the factors in rail manufacture which influence rail quality. One recommendation which resulted from this work is that the drop-test should be made with rail-head down, as this detects deficient ductility better than when the drop-test is made with the base down.

A rather radical recommendation was made by R. W. Hunt (U. S.) to the end of insuring soundness in steel rails. He states that a sufficient discard from the top of the ingot is not generally made, and that the drop-test made on one ingot from each heat tests only that single ingot, whereas the defects reside in the individual ingots rather than in the individual heats. He concludes that a test should be made from each ingot; by making this test on crop ends and actually breaking the rail across in the test, the cross-section of a rail from each ingot will be exposed, and the interior and its structure can be examined. The author believes that this routine can be carried out with only an insignificant increase in cost. H. D. Hibbard (U. S.) in discussion urged that improvement in casting the ingots is more important than improvement in testing. Mr. Hunt did not deprecate this suggestion but proposed that until the necessary improvements in casting ingots are developed a test procedure which will test each ingot is certainly desirable.

An illustrated lecture by R. Job (Canada) was the particular feature of the rail session. Mr. Job reviewed the general subject of defects in steel rails with the aid of a large number of lantern-slide views, showing different kinds of internal defects. He then showed a half-dozen slides illustrating a new defect which he has studied particularly during the past year or two: a transverse crack or fissure developing from a focal point in the interior of the rail and gradually spreading outward until the surface is reached. Such defects have been observed both at breaks of rails and at sections not yet broken where the defect was wholly interior and had not yet reached the surface. Defects of the latter stage have been found in various sizes from less than ¼-in. diameter of fissured area to nearly up to the point of reaching the exterior.

Cast Iron

Prof. William Campbell and John Blackford (U. S.) introduced the subject of cast iron by a paper reciting experiments on some castings exposed to superheated steam and corroded or disintegrated thereby, and experiments made on a range of samples of pig iron, cast iron and steel subjected to long exposure of superheated steam or to many repetitions of heating or cooling. Micrographic study showed that white cast iron, malleable castings and steel oxidized superficially only; but in gray cast iron the oxidation penetrates deeper, following the graphite flakes. The higher the silicon content, the greater is the change. Pig iron containing 5½% Si was thoroughly altered by superheated steam, with the appearance of a new constituent surrounding the oxide areas. Some discussion confirmed the general evidences of destructive oxidation reported by the author and indicated that experiments are in progress elsewhere on the same subject.

Seven further papers on cast iron were then read. J. J. Porter (U. S.) opened with a review of the principal classes of iron castings, describing the service requirements and the variations in foundry practice which are usual in meeting these requirements. He suggests the general features which should characterize tests for these different services. A. Damour (France) reviewed the subject of mechanical tests of cast iron, and by showing results of experiments he demonstrated the influence of various factors affecting the production of the testpiece and the conduct of the tests. He urges that uniform test conditions be established, with a view to formulating ultimately an international standard testpiece.

Standard test-bars already have been set up in England, Germany and the United States, differing, however, in dimensions and in some of the conditions under which they are produced. J. E. Stead (England) reported, for the British members of Committee 1b, a series of experiments made in order to compare these different bars. The conclusion is that the English form makes it somewhat more difficult to secure sound testpieces, but except for this effect the form of testpiece does not greatly influence the result. A round testpiece is preferred, and the length of 24 in. is regarded as a minimum (against the standard 18-in. length of America).

Charles Fremont (France) suggested a new mechanical test for cast iron, on the ground that it is practically impossible to make satisfactory tension tests. On finding that static bending tests and shearing tests give results proportional to each other, he has developed a shearing test made upon a very small testpiece, which can be taken out of a casting without injuring the casting. A ¼-in. cylinder is drilled out by a core drill, and a square testpiece worked from this is sheared every ⅛ in. along its length, giving information on the strength at different depths below the surface. This test, as well as the following one, suggested by Thomas D. West (U. S.), received no discussion, however. Mr. West's proposal applies to chillable iron, with which material, he suggests, it is important to test both the white condition and the gray condition. A pair of molds was, therefore, designed by him, one being for the gray bar and the other for the chilled bar, both giving a bending testpiece 2¼ in. diameter by 18 in. long, for 12-in. span, and fitted also to enable the contraction on cooling to be measured.

Malleable-iron practice was discussed by R. Moldenke (U. S.), who voiced his protest against the modification of malleable practice in the direction of making malleable castings resemble steel castings, inasmuch as all the desirable elements of malleable castings are sacrificed by this proceeding.

The old and important question of grading pig-iron was brought up by J. Kail (Austria), who argues that only chemical analysis should be used as a basis of grading. His principal suggestion is that pig iron be graded according to silicon content. Discussion by R. Moldenke and W. Wood (U. S.) referred farther to the difficulties of establishing any basis for the grading of pig iron, and inclined rather to the sale of pig iron according to analysis without attempting to set up a classification into which all pig iron must be fitted. E. G. Wolff (Germany) defended the tension test of cast iron and stated that with a bar of section reduced in the center it is quite possible to make satisfactory tension tests. E. Adamson (England) advocated grading by carbon content, that is, by appearance of fracture only.

Special Steel

The subject of special steel was discussed in the same section with cast iron, and unfortunately out of relation to the other papers dealing with steel. Perhaps for this reason the subject was not discussed. L. Fea (Italy) reported the results of a large series of tests on steel for naval use, in which tensile strength, hardness, endurance, etc., were determined. It was found that none of the tests gave a satisfactory index of the resistance to shot penetration. S. de Fabry (Hungary) presented the results of mechanical and micrographic tests of tool steel annealed at various temperatures between 600° and 1000° C. The steels varied from 0.58% to 1.36% carbon; tests were in tension and hardness. Strength and hardness decreased as the annealing temperature was raised to 750°, and thereupon increased, while ductility decreased. Steel of eutectic composition showed higher strength than those of lower or higher carbon. The author's conclusion is that mechanical tests will not give a proper index of steel quality, since the results are affected by heat treatment to such an extent as to make chemical analysis the only reliance for proper grading.

The relation of chemical composition

of steel to electric resistivity was investigated by O. Boudouard (France), who worked with carbon steel, nickel steel, manganese steel, chrome steel and tungsten steel. He found it possible to apply Benedicks' formula successfully to coördinate his results.

The action of carburizers was studied by De Nolly and Veyret (France), who found the cause of explosions in case-hardening to be the hydrogen given off at high temperatures from the carburizers. This last paper appears to have been grouped with the papers on special steel for lack of a better place.

Non-ferrous Metals and Alloys

Ten papers on brass, copper and non-ferrous metals and alloys were presented, in addition to the report of Committee 38, on principles of specifications for copper. L. Guillet (France), chairman of this committee, presented nine resolutions which would constitute the clauses of a copper specification. It developed at the meeting, however, that the most important copper interests had been left out of consideration in framing this report, and that the report does not represent the wishes of the committee. The English contingent made objection that the report did not represent its opinion, and representatives of the American copper interests and the American members of the committee had not been given any standing in the committee's report. The result was a resolution referring the whole subject back to the committee. The resolution as finally framed and approved by the council and by the general session of the congress was printed in our last issue. It is non-committal as to any attitude of the association toward the proposals submitted by the committee and the committee is asked to continue its work.

Bearing metals and miscellaneous alloys were considered in three papers. N. Pecoraro (Italy) reported researches on bearing metals of the white-metal class. The general conclusions of his research are that the hardening test is somewhat related to wear resistance, that impact tests may give indications as to brittleness, and that compression tests may serve to fix the limiting load for the metal in the bearing. Other mechanical tests have no value in determining the serviceability of metal for bearing use. F. Cremer (U. S.) reported the experience that babbitt metals containing about 20% hard constituent and 80% plastic constituent have given better satisfaction under severe service (woodworking machinery) than homogeneous alloys, probably because they facilitate lubrication.

Bearing metals of the bronze class were studied by A. Portevin and E. Nusbaumer (France), who made wear tests by means of the Derihon abrasion-test machine. It was found in these tests that a hardened skin may form during the test, which shows very slow wear, but as soon as this skin is worn away a period of very rapid wear is initiated. When a hardened skin of this kind is present there is found to be a tendency to crystallization on annealing.

H. LeChatelier (France) described some further experiments on the production of a series of alloys in a continuous zone by bringing two small particles of the alloying metals in contact in the fused state. It is now possible to make the alloy-zone so narrow that a microphotograph of the entire series can be taken on a single plate. Prof. H. M. Howe (U. S.) characterized this superposition method of forming alloys as only a demonstration method but not a method for investigating alloys. The quantity of each particular stage of the alloy is too small for proper examination, and it is probable that each stage is not in its true equilibrium condition. Even the Brinell hardness test could not be applied on such a minute quantity. C. E. Skinner (U. S.) described a related method of forming alloy zones, by heating two pieces of different metal, welding them together and holding them at a temperature slightly below the melting point by means of an electric current; under these circumstances a sort of transfusion takes place, each of the metals traveling into the other one, in some cases for a distance of as much as 2 in. The alloys produced under these conditions are subject to study like those of Prof. Le Chatelier.

Chemical studies of several phosphides were reported by P. Jollibois (France), who studied in particular the phosphides of tin, nickel and zinc, discovering certain new phosphides in this work, and giving the formulas for the entire series of phosphides of the three metals.

As a new means of studying structure of alloys, W. Broniewski brought out the importance of electric measurements. The five quantities which may be studied are: Resistance, temperature-coefficient, thermoelectric power, its temperature variation, and e.m.f. of solution. Curves of these properties for progressively varying percentage of alloy indicate specific compounds or mixtures by certain peculiarities of the curves.

A subject of much practical interest was brought up by W. R. Webster (U. S.), who gave the results of strength tests to show the effect of cold-working on various metals, chiefly of the copper and bronze class. Tests were made on the original annealed metal and on specimens of the same bar reduced in thickness by rolling, the maximum reduction in these tests being down to 30% of the initial thickness.

Further information concerning the physical properties of alloys was given by I. M. Bregowsky and L. W. Spring (U. S.), who reported the results of tensile tests of 18 well known alloys at temperatures between 70° and 1000° F., and torsion tests of rolled rods of 15 alloys at temperatures between 70° and 600° to 800° F. The paper presented the results in the form of curves on a temperature base.

The value of micrographic study of copper and alloys was emphasized by H. Baucke (Holland), who reported some new observations on crystal size, growth of crystals from heating, etc., in copper, and by Capt. C. Grard (France), who described how micrographic study may be made useful commercially to show the amount of cold-working and annealing; the latter's tests were made on a 67-33 brass and a 90-10 brass, and the general result was that the micrographic structure indicated the prior treatment quite definitely.

As a new test method for copper, H. Baucke (Holland) discussed the application of the notched-bar impact test to copper. The Fremont apparatus was used. The effect of forging in raising the resilience of cast copper was made clearly evident, and the deleterious influence of oxygen and of bismuth also was brought out.

Micrography

The last session of Section A dwelt largely with micrography. Perhaps the most important element was the report of Committee 53, on the microscopic constituents of iron and steel, presented by Prof. H. M. Howe (U. S.). This report includes in its scope all microscopic constituents and structures for which designation names have been used to any important extent, and gives definitions. Auxiliary descriptions and remarks on the theories held by different students are included, but are kept clearly distinct from the primary definitions. The committee's report was accepted by the meeting without dissent, and the definitions which it proposed were adopted as standards. The formal resolution in this matter appeared in our last issue.

In the micrographic group of papers a prominent place as to interest is due a paper by Prof. A. Sauveur (U. S.), who described the crystalline growth of ferrite at temperatures below its thermal critical range. Prof. Sauveur found that when a bar of steel is strained beyond its elastic limit and then annealed for several hours, a particular zone of metal is found to have its crystal size enormously increased. This zone is intermediate between the most highly strained portion and the least strained portion; in other words the crystal growth does not take place under great overstrain or under small strain, but only in a narrow and usually sharply defined intermediate range. Dr. W. Rosenhain (England) offered some parallels to the observations of Prof. Sauveur, and suggested that a theoretical explanation of the phenomena observed might soon be forthcoming. He

cited the formation of amorphous slip bands in strained plastic metal as an analogy, pointing to the uniformity of crystalline growth below a certain strain. Prof. H. M. Howe (U. S.) suggested that in wiredrawing, where the wire fails to show increase of strength beyond a certain reduction, there is a similar occurrence to that observed by Professor Sauveur. Prof. A. Rejtö (Hungary) reported that in testing steel by straining to the limit of proportionality, to the yield-point, and beyond, he found that crystal growth began at the yield-point, both in tension and in compression, whereas beyond the yield the crystals became smaller again.

A most compendious review of advances made in metallography since 1909, was given by Prof. E. Heyn (Germany). All the separate fields of the investigation of metal and of microscopic study of metals and their structures are reviewed separately, with ample citation of bibliographic references (540 entries), and with expression of opinion on a variety of unsettled points, especially on the constitution of iron.

A necessary improvement in microscopic research was suggested by M. C. Lothrop and C. R. Bulley (U. S.), who referred to the great diversity of micrographic enlargements used by various authors, and pointed out the necessity of having certain standard magnifications in order that the eye may be able to transfer readily from one scale to another. They made certain specific suggestions, but the matter was dropped by the congress without action. A suggestion of a somewhat different nature, also tending toward uniformity, was made by F. Robin (France), who suggested that the nomenclature of microscopic constituents be built up on a rational basis; this suggestion also was dropped without further action.

Three papers giving important new information in the micrographic field were presented by the Testing Laboratory of the P. L. M. Ry. (France), F. Robin (France), and H. M. Howe and A. G. Levy (U. S.) The paper of Mr Robin was a review of various observations indicating changes in the constitution of iron below 700° C. Prof. Howe and Mr. Levy reviewed the genesis of cementite, as steel of hypereutectoid composition is cooled from high temperature down to normal, during which cooling the cementite coagulates and grows.

Nomenclature of Iron and Steel

The report of Committee 24, presented by Prof. H. M. Howe (U. S.) proved to be a very extensive document, whose essential element was the proposal to standardize the term "steel" as meaning all malleable iron material produced by casting from a fluid state. It developed that the committee had been unable to get more than a small number of its membership to take any part in the discussion and work preliminary to making its report, and also that most immovable opinions of contrary tendencies are held in Germany, in England, and in some sections in the United States, concerning various items in the nomenclature of iron and steel. The contest which the opposing element made at the congress was such that finally Prof. Howe was forced to withdraw the report and acknowledge the utter impossibility of reaching any conclusion on the subject. He proposed the dissolution of the committee, but, after it was pointed out that the association's custom is for the council to undertake all creation of or changes in committees, the matter of dissolving the committee was finally left to the council. The list of technical resolutions, given earlier in this report, in consequence contains no reference to the work of Committee 24.

Investigations of New Testing Methods and Proposed New Tests

A thorough study of the thermo-electric method of measuring stress was begun during the last year by J. A. Capp and T. R. Lawson (U. S.) This method bases on the fact that when a piece of metal is strained to near its elastic limit the straining begins to develop heat, and a thermocouple will indicate the production of heat very accurately. The experiments so far made were reported at the congress; they covered about forty specimens, the curves for which are given. In spite of the accuracy of the test work the work is quite inconclusive as yet and it will be continued.

Several new tests were reported by Charles Fremont (France), in addition to one or two previously noted. One of these, a method for testing rivet-steel, was described by the author in the *Genie Civil* of Nov. 19, 1910 (Engineering News, Jan. 12, 1911, p. 41); the test is intended to measure the gripping power of the rivet. A proposed new method for testing steel wire to detect internal flaws involves an application of the notched-bar impact test, but in order to localize the impact-bending effect on the middle of the piece it was found necessary to surround the ends of the wire with tight-fitting sleeves. The further development of this method is described. With less special modifications the impact test was applied by Mr. Fremont to tests of welds, in which case it is necessary to have the testpiece lie directly across the weld. Mr. Fremont concludes that a weld, even when perfect, is always weaker than the metal, and that the perfection of the weld can never be known until the piece is broken.

Welds—Animated discussion developed on the subject of the qualities of welds. A. Denny (England) objected to Mr. Fremont's statement that welding should not be allowed unless fracture would not involve danger. He pointed out that welding in a great many instances cannot be dispensed with, and while tests have shown that welds though often of strength equal to the normal metal are deficient in ductility, yet they are sufficiently reliable as shown by practical use. R. H. Danforth (England) agreed with these sentiments and pointed to the extensive use of lapwelded pipe. Dr. W. Rosenhain (England), referring to some extensive tests of welded joints made at the National Physical Laboratory, stated as his opinion that the remark of Mr. Fremont should in general be agreed with. He suggested that if the remark is taken in a general sense, it is perfectly justified by the present state of knowledge on the subject and is not in disagreement with the practice of using welded chains, etc., where it is not well possible to avoid welding. E. Heyn (Germany) rather took an opposite view, however, defending the quality of welding when properly done. He says that there are not only individual cases but many cases in which welding is thoroughly well done and is thoroughly successful. It is necessary to avoid overheating or to cure overheating by heat treatment or forging. He opposed the view that welded joints should be looked upon as danger spots, and stated that in Germany there are many manufactured articles and structures subjected to the most severe requirements where welds are used, and used without difficulty.

The subject of welding was discussed by M. Bermann (Austria) in two papers, one on the theory of ordinary welding, and the other on the nature of autogenous welding. His view is that in ordinary welding the reduction of the iron oxide on the contact surface is effected by means of the metalloids in the metal itself (manganese, phosphorus, silicon, etc.). The temperature at which the rapidity of this reducing action is greatest is the proper welding temperature. Similar reduction takes place in autogeneous welding, but in this case he recommends that the welding flame be slightly oxidizing in order to avoid too great a reducing effect on the metal.

On Bermann's explanation of welding, F. N. Speller (U. S.) objected that in commercial welding of pipes, for example, several times as much cinder is formed during the process as is originally present on the plate, and the process goes on under essentially oxidizing conditions; for this reason he does not believe that a reducing reaction takes place as held by Mr. Bermann.

A chemical method for carbon determination in ferrous metals was described by H. De Nolly. The method is based on burning the metal in pure oxygen with electric heating, absorbing the carbon dioxide in alkali, and titrating the alkali for excess.

A peculiar electrical phenomenon was

discussed by Prof. K. Benedicks (Sweden). By letting sparks pass between metal surfaces in liquid, there are formed minute fusion craters on the surface. These craters represent spots where the metal was fused by the current jumping across the gap, the fused particles having then been blown outward by mechanical reaction. When this disintegration of the surface is carried far enough to cover the entire surface, any lack of uniformity of the metal is shown very strikingly. In steel, slag inclusions or uneven distribution of the cementite are made clearly apparent to the naked eye, and in cold-worked materials localized disintegration is seen.

Mr. Bermann has in the past studied particularly the subject of indicating the nature of metal by the sparks thrown off when the metal is held against a grinding wheel, on which subject he reported to the Fifth Congress, at Copenhagen, in 1909; he believes that since he now finds it possible to determine by means of these spark pictures the carbon, silicon and manganese content of iron or steel quite accurately, the association should undertake officially a study of this "spark test."

A difficult and extensive series of experiments with impact-tension test machines was reported by Prince A. Gagarin (Russia). He began by attempting to measure the force exerted in the impact test through a very stiff spring supporting the specimen, but finally adopted a crusher as the support of the specimen, measuring the downward motion of the specimen on the crusher as a gage of the force exerted; at the same time the movement of the ram was measured to give the corresponding strain. The final apparatus employed a narrow beam of light reflected from two mirrors in succession at right angles to trace the resulting stress-strain curve on a photographic plate. The subject of the influence of vibration in the apparatus upon the result was studied exhaustively; the final form of the apparatus appears to eliminate vibration satisfactorily. This paper was presented as an illustrated lecture, in which the author showed the apparatus, the test specimen, and curves of results obtained in various stages of his development of the work.

Section B

SO_3 Content in Portland Cement

The Association of German Portland Cement Manufacturers presented a proposal for a standard SO_3 limit for portland cement. This proposal stated that at present the limiting amounts of SO_3 in portland cement in standard specifications in different countries are as follows: Germany and Austria, 2.5%; England, 2.75%; Canada, 2%; United States and Russia, 1.75%; France and Brazil, 3½% (1.5% for seawater use); Argentina, 2.4% (1.2% for seawater); Japan, 2% (1.5% for seawater). Tests made in Germany show that 2.5% SO_3 is unobjectionable in seawater, and even that a cement of 0.6% was inferior to the same cement raised to 2.5% as well as to other cements of 1.2% and 2.5% of SO. In seawater the cement high in SO_3 suffered little chemical change, while the cement low in SO_3 underwent much change. The proposal is that the congress recommend generally the specification of 2.5% maximum SO_3 in portland cement for all uses.

This subject, as may be noted from the abstract just given, is another one in which the practice of the various nations differs, and one which at the present time seems difficult of satisfactory arbitration. After some discussion the congress decided to pass a resolution printed in the article of last week, recommending a committee to investigate the influence of SO_3 and to report at the next congress.

J. Bied (France) described methods which enable various important deductions as to the chemical constitution of cements to be drawn from simple tests.

Durability and Tests of Stone

A set of three papers was read on the general subject of the durability of masonry: the first by J. A. van der Kloes (Holland) for Committee 50 described the work of the committee and presented some analyses of stone and mortar where efflorescence had appeared. He suggested that osmotic pressure is a possible factor in the decay of masonry walls and that an excess of lime in masonry and concrete is leached out. It is probable that a relation exists between excess of lime in mortar and the production of efflorescence, although that efflorescence may contain but little lime. A. Hambloch (Germany), in a paper, objected to the ratios of puzzolana to lime or cement recommended at the Copenhagen Congress. He said that these mortars contain about twice as much trass as they should. He also stated that the claim that mortar is a factor in the disintegration of masonry lacks proof, and if such relation exists it is of importance only in rare cases.

Reporting for Committee 7, A. Hanisch (Austria) proposed to the congress a resolution that testing laboratories be asked to introduce the Hirschwald method in their work.

Two papers on the testing of stone were presented: The first by A. T. Goldbeck and F. H. Jackson (U. S. A.) took up the question of broken-stone railway ballast, and recommended that the tests used in the U. S. Office of Public Roads be adopted. A table of test results was appended to the paper. P. Labordère and F. Anstett (France) described the Paris municipal testing laboratory's methods of testing the 3,000,000 paving blocks it buys each year.

Plastic Mortars

The subject of uniform testing of cement was reported on by Committee 42 by F. Schüle (Switzerland) and M. Gary (Germany). Mr. Schüle stated that his proposal of 1906 to test cement in 1:3 mortar tempered to plastic consistency and formed into prisms 4x4x16 cm. to be broken in bending has been studied in comparative tests with various continental sands. The results vary so consistently that he recommended that in each country a testing laboratory should make a series of comparison tests against the established German sand to establish proper relations. Test bars of machine-rammed dry mortar showed slightly greater variations and lower two-year strengths than test bars of hand-molded plastic mortar. Mr. Gary in his report stated that, although the question of dry-rammed versus plastic mortar for test pieces has been studied in Germany previous to Schüle's proposals, 16 laboratories made extended tests after those proposals. Compression tests with plastic mortar showed greater variation between the individual laboratories than tests with dry mortar. Bending tests with plastic mortar showed greater variations than either set of compression tests. Mr. Gary therefore could see no reason for considering a departure from standard German methods. On the other hand Dr. E. Probst (Germany) advocated the adoption of plastic mortar tests, on the ground that practice in Germany is generally turning to the use of wet-mixed concrete. Mr. Gary objected that cement-testing is in question, and not concrete-testing, but Mr. Probst said that his demand related to tests of cement, and that the general need is to test materials as nearly as possible in the state in which they will be used. Also, in answer to Mr. Gary's statement that he should first have raised this point in Germany and let it be settled there, he remarked that he had had no opportunity to present his view at home.

Here the congress had before it another stubborn difference, which obviously could not be settled without one side giving way. The solution was the usual compromise resolution, which was printed in our last issue.

Action of Seawater on Concrete

Three papers on this subject were read. The first by V. J. P. de Blocq van Kuffeler (Holland) reported that experience in his country indicates that reinforced concrete is sufficiently permanent to warrant its use in seawater construction, though probably not eternal. He recommended the following rules to be adhered to: Only slow-setting portland cement should be used; mixing and ramming must be done with great care; trass or other puzzolanic additions are desirable; the mortar should be dense and the mixture

rich; setting in moist air before immersion in the sea is advantageous.

W. Czarnomski (Russia) described some blocks of stone masonry and blocks of concrete which were deposited in Libau harbor in 1891 and 1898, and were examined in 1905 both externally and (after blowing part with explosives) internally. All were in satisfactory condition, with some evidences of dissolving or disintegrating action. Chemical analysis showed that the cement in all the blocks had altered by decrease of lime and increase of magnesia and sulphuric acid.

Messrs. Lombard and Deforge (France) described some tests of hydraulic limes and cements in seawater, which were started in 1852. A block of Vicat's maritime cement placed neat in 1859 was in good condition in 1911. Portland cements undergo three forms of change: high-lime cements check and break up from swelling, correctly proportioned cements decompose without appreciable expansion and low-lime cements develop surface cracking and disintegration.

Edwin Duryee (U. S. A.) in the discussion stated that some tests of his had shown that puzzolana cement mortars show a growth in strength in seawater brine over similar testpieces in fresh water. N. Belelubsky (Russia) said that in the North Sea, Russia has under construction the first concrete work in seawater where puzzolana cement is used. This cement is found in the Crimea and resembles the Italian puzzolana.

Tests of the action of different materials to secure watertightness of concrete were reported by A. Grittner (Austria) and J. Bied (France).

A final paper on this same general subject was read by M. Gassier (France) who reported that experiments had shown that sands made of crushed rock are in general fully equal to natural sand in lime and cement mortars exposed to seawater, and also as regards strength.

Electrolysis of Concrete

A short paper by C. de Wyrall (U. S. A.), reporting certain apparent destructive effects of electrolysis on unreinforced concrete, was printed in the Proceedings of the Association and was scheduled to be read at the congress. The paper is reprinted in full on another page of this issue. At the appointed time a communication was read from the author asking that the paper be not read at the meeting and be also withdrawn from publication in the final report of the congress. The chairman of the section ruled that the question of final withdrawal must be settled by the Council, but that the paper should not be read in the session. On appeal from the floor he reversed this decision to the extent of permitting discussion on the general subject of the electrolysis of concrete. The only discussion was from H. Muller (Germany), who said that tests on the electrolysis of reinforced concrete had been made in the grand-ducal laboratory at Darmstadt and the results published in book form, and from P. H. Bates (U. S. A.), who reported similar tests about to be described in a publication of the U. S. Bureau of Standards. Both of these discussions, however, related to the subject of reinforced-concrete electrolysis, and not electrolytic action on plain concrete, which was the subject of the original paper.

Reinforced Concrete

Reporting for Committee 41, F. Schüle (Switzerland) presented a general resumé of the subjects under investigation by the committee. The report proposed a resolution favoring the adoption of a uniform form of report on reinforced-concrete accidents, and a standard list of mathematical symbols for reinforced-concrete calculations. Appended to the report were separate reports from the members of the different countries, describing the state of reinforced concrete in the respective countries. Prof. A. N. Talbot (U. S. A.) stated that the printed report accredited to him was the same as the one he presented in Copenhagen in 1909, and orally he brought the report to date by explaining the various steps, particularly in testing, which had been taken in this country since that time.

H. Scheit and E. Probst (Germany) reported results of tests on continuous structures of reinforced concrete, which brought out the important influence of distortion in the abutments or supports.

F. von Emperger (Austria) recommended in a paper that official reporting of accidents be made a matter for the study of the congress. This was taken care of in a resolution which appears at the beginning of this article.

Prof. F. Schüle (Switzerland) gave results of tests showing a constant relation between crushing strength and elasticity of concrete, so that the factor of safety of a reinforced beam rises with crushing strength.

Tests for Concrete

C. M. Chapman (U. S. A.) urged the action of the congress upon a standard test for finished concrete, and enumerated and briefly described 12 possible forms of tests. These in brief may be stated as: Molded-specimen compression test; molded-specimen tension test; cut-specimen test; penetration test; indentation test; duplicate-member test; standard-member test; tension test; improved tension test; modified tension test; absorption test; deformation test. While no definite action was taken on this paper, it was stated in session that its recommendations were cared for by one of the resolutions.

Section C

Paints

A. S. Cushman (U. S.) opened with a summary of the subject paints for metallic structures, pointing out the great attention given in recent years to the question of influence of pigment on the underlying metal and to the electrolytic hypothesis of corrosion. The exposure tests at Atlantic City and Havre de Grace, and studies of paint vehicles, were also mentioned. G. W. Thompson (U. S.) presented the suggestion that in speaking of paint mixtures the volume relation of the several constituents should be borne in mind rather than the weight relation, as it is the volume relation that controls in the structural makeup of the paint.

P. Labordère and F. Anstett (France) discussed the testing of anticorrosion paints. In order to study paint films they devised a method of preparing such films by painting upon a coating of sugar on drawing paper and subsequently dissolving away the sugar. Tension tests were made upon such films at various periods after drying and after exposure to various deleterious influences. Good agreement between parallel tests was obtained. Some preliminary results were given, but the tests are to be continued. G. W. Thompson (U. S.) suggested that the solubility of sugar in fatty oils should be borne in mind, this being the reason why the method proposed was not used in the United States, but the authors replied that these films gave the same result as films made on tin when the tin was dissolved away with mercury, so that apparently the sugar had no influence on the test.

A remarkably interesting paper by Dr. Shohe Tanaka (Japan) was presented in the form of a discussion, the paper having arrived too late for inclusion in the program. It described the application of Japanese lacquer to the exterior finish of (wooden) passenger cars in Japan. The lacquer is very hard and tough and takes a fine polish; in Japan, lacquered dishes are used in place of porcelain for serving food, the material being unaffected by water, alcohol, oil, alkali and acid. Some sample panels of wood which had been lacquered by the process used for passenger cars were shown. Where the wooden surfaces to be lacquered are jointed a hemp fabric is applied over the under coat of lacquer, and over this is applied a mixture of lacquer and clay powder. A surfacing coat of paint is put on over the lacquer, but an intermediate film is required to make the paint stick to the lacquer; both gelatin and formalin and a mixture of gelatin and potassium manganate have been used for this film.

Bitumen

P. Hubbard (U. S.) presented an argument similar to that of Mr. Thompson in the matter of paints, in application to bituminous aggregates for paving. He

suggested that the volumetric composition of such a bituminous mixture should be considered instead of the weight ratios, as the volumetric composition determines the structure of the mass. C. S. Reeve (U. S.) discussed the variation in the penetration test of bituminous materials introduced by changes in the size of the vessel in which the bitumen is placed for test.

A definite proposal for improvement in the literature of bituminous substances was made by D. Holde and I. Marcusson (Germany), who presented a classification of bitumens based upon chemical characteristics. C. Richardson (U. S.) pointed out that in the United States and Germany the word bitumen covers not only natural bitumen but also products of destructive distillation, whereas in France and England the word refers only to natural products. For this reason he is of the opinion that international agreement will not soon be reached. P. Labordère (France) objected that no classification or series of definitions should be formulated except in conjunction with the International Road Congress, and a resolution to this effect was formulated.

Tests of Explosives

C. Hall (U. S.) presented an extended paper comparing some of the methods used in various explosives-testing stations for testing explosives, and pointing out the radical differences in results which are due to differences in test methods. He urged that means be found for bringing about uniformity of test methods. F. Cellerier (France) objected that the subject brought up by this paper is not properly within the scope of the Association's work; in his view the Association is devoted specifically to tests of constructive materials, and a subject such as tests of explosives should be referred to an organization like the Applied Chemistry body. No action was taken on Mr. Hall's suggestion.

Fire Tests

Two papers were presented on fire tests, the first by E. O. Sachs (Great Britain) for the British Fire Prevention Committee. This committee has made fire tests since 1899, amounting to nearly 200, all of which have been reported in separate books. The paper describes the plan of work and the test procedure, and recommends certain resolutions which were finally adopted, as noted earlier in this report under the heading Resolutions, which appeared in our issue of last week. The second paper by I. H. Woolson and R. P. Miller (U. S. A.) was on "Fire Tests of Floors in the United States." This paper embodies a brief history of the development of testing the fire-resisting properties of building materials and construction in the United States, with a description of the various equipments now in use for this purpose and a general status of the work. A long tabulation giving details of about 80 floor tests will accompany the paper in its final printing. In connection with these two papers, Prof. M. Panetti (Italy) brought before the congress a proposition to consider as a separate problem the question of stability of structures under earthquake action. Prof. Panetti says that this presented three viewpoints. First, the mathematical side which should look into the methods of calculating stresses produced by earthquake movements; second, the experimental side, which consists of tests of materials under actions similar to those caused by earthquakes, and third, the practical side, which should consider the choice of materials and combinations of materials which will give the most economic solution of the problem. He described in some detail the progress of the Royal Italian Commission which was appointed after the earthquake at Messina in 1908.

Oil Testing

Three papers on oil testing led to extended and animated discussion, which, however, brought forward little new material of value. L. Fea (Italy) gave the results of various studies of the viscosity of lubricating oils. He found that viscosity measurements made with the Engler apparatus are satisfactory measurements, and that there is a direct proportionality between these figures and the wear coefficient obtained with the Goodman apparatus. E. Camerman (Belgium) reported some tests of cylinder oils for superheated-steam service. The essential qualities of lubricants for such service were discussed, as were also test methods applicable to them. For measuring lubricating efficiency he referred only to the Martens oil-testing machine, but stated that this does not readily permit of testing at high temperatures, the limit being practically at about 125° C., whereas superheated-steam service requires temperatures in some cases up to 350°. M. Albrecht (Germany) made a brief statement concerning the investigations of lubricating oil now being carried on in Germany, and referred also to the recent formation of the International Petroleum Committee.

As a separate matter Mr. Albrecht, who is chairman of Committee 39, on Oil Testing, proposed the dissolution of Committee 39 on the ground that the work is well taken care of by the International Petroleum Committee, and further on the ground that he had been unable to get his committee together for work. The latter statement was strongly denied by several members of the committee present, who retorted that Mr. Albrecht had not addressed a single communication to his committee and had made no effort to get it together; they also asserted that there is distinct need for work outside of that done by the International Petroleum Committee. As a result a resolution was prepared and accepted by the section and later adopted by the congress at its general session to the effect that the oil committee be continued and be urged to begin and prosecute its work promptly.

Discussion of the subject of oil testing by E. Camerman (Belgium), A. Jacobsen (Denmark), G. L. Fowler (U. S.), P. H. Conradson (U. S.), and others, showed a general disagreement on the proper test qualities for high-temperature lubricating service. Viscosity is found to be a very insufficient guide, and the only recourse is to determine the various measurable properties of oils which give good service and to compare the corresponding properties of other oils (and also test them in service as a check), on the assumption that good service will be obtained when the measured properties correspond with those of the satisfactory oils.

Tests of Road Material

At the request of the International Road Congress some time ago the Council of the International Association for Testing Materials appointed a committee under the direction of A. Mesnager (France) to report on the tests of road materials practiced in different countries. Full reports were submitted by H. Burchartz and B. Stock for Germany, A. Hanisch for Austria, E. Camerman for Belgium, H. I. Hannover for Denmark, A. Fock for Budapest, M. Skougard for Norway, and M. E. H. Tjaden for Holland. The reported test methods deal almost exclusively with broken stone for macadam, stone blocks, stone and artificial stone slabs, and but little with asphalt and other auxiliary materials. The report of Mr. Fock for Budapest describes some long-time wear tests conducted in different busily traveled streets with stone-block pavement. The reports of the German methods are exceptionally full. The entire committee report was, however, not discussed. A resolution on the subject was adopted by the congress at its final session as recorded in our last issue under the heading of Resolutions.

Rubber Testing

A short paper by F. W. Hinrichsen (Germany) reviewed the present state of chemical analysis of rubber and referred to the fact that (generally speaking) only indirect methods of analysis can be used, vulcanized rubber being the most difficult variety for analysis. A procedure of indirect analysis of vulcanized rubber is outlined which is applicable in the more common cases.

Two papers on rubber testing were presented by K. Memmler (Germany) and P. L. Wormeley (U. S.). The Prussian state laboratory at Gross-Lichterfelde, Germany, some years ago became dissatisfied with the straight-strip tension test of rubber and developed the so called

ring test, in which a ring-shaped specimen is placed over two rollers which are slowly rotated and at the same time are pulled apart. The Bureau of Standards on the other hand has had good success with the straight-bar test, and finds it to have the advantage that it permits the longitudinal and the transverse strength of the rubber to be obtained separately, while the ring test does not discriminate and will usually give the transverse strength. Results of the two kinds of tests are not concordant. The discussion of the two papers was largely a controversy between Mr. Memmler and D. E. Douty (U. S.) representing the two forms of test. It also developed several questions as to whether tests for aging of rubber have been made, and it appears that such tests on a rather large scale are in progress in the United States and some have been undertaken in Germany. C. E. Skinner (U. S.) remarked that tests on the effect of exposure of rubber wire-covering upon the insulating strength had been made some years ago, covering a 10-year period, with discordant and inconclusive results.

An accelerated aging test, or rather experiments toward the production of accelerated aging, was described by A. Jacobsen (Denmark), which consisted in keeping comminuted rubber in contact with oxygen and noting the time during which oxygen was absorbed.

Stresses and General Testing

Prof. A. Rejtö (Hungary) presented a discussion of the bending strength of tenacious materials, of strongly theoretical nature. More practical tendencies characterized a paper by O. Greger (Austria), who discussed the relation between yield-point and buckling strength. Some experimental results on this subject were cited, and the author ended with the proposal that the Association should officially designate the subject as one for study. This motion failed of ultimate adoption, however.

A question of large engineering importance was brought up by Prof. H. F. Moore (U. S.), who described the various kinds of elastic limit observed in different kinds of tests of materials. One of the limits discussed by him, the heating limit, had been reported on by Capp and Lawson before Section A. Prof. Moore similarly described the limit of proportional strain, the limit of set, the fatigue limit, etc. He concludes from a review of all available experimental facts that at present we are unable to give superior importance to any of these limits except the yield-point, and that this latter, which is also the most readily determined, has the greatest value in relation to the use of the material.

Testing Laboratories and Machines

Dr. A. Martens (Germany), the director of the German government laboratory, near Berlin, presented a paper entitled "Principles for the Organization of Public Laboratories for Testing Materials," in which he specified the functions of a public test laboratory, after pointing out the need of such institutions. The two important functions of such a laboratory are the arbitration of disputes over materials and the giving of unbiased expert opinion. To keep such a laboratory on a thoroughly impartial basis, it should be just as independent of the governmental bureaus as of manufacturing interests. Its services should be available to every citizen for a charge proportional to the cost. In the same connection, Ernst Reitler (Austria) described the testing office of the department of public works in Austria, which was established in 1910 to promote public testing work and to supervise public and private testing laboratories. The supervision is exercised through a grant of authorization to issue test reports which shall be recognized as valid public documents. The bureau may also grant financial support for developing public or commercial laboratories.

Under the general subject of testing machines, Prof. Martens (Germany) read a paper on the reliability of testing laboratories, testing machines and strength tests. He said that the reliability of test results depends on accuracy of machines, uniformity of material, proper sampling, uniform manipulation, etc. The calibration of machines and expert sampling are in practice found to be very important. Variation of results due to accidental errors is best studied in terms of mean variation in a series of observations. This principle may be used to decide between different forms of test for a different material, to compare the inherent homogeneity of different materials, to compare the performances of different laboratories, etc. After computing the mean variation of each series in several series of parallel tests, a more correct average result may be obtained by weighting each series in proportion to the reciprocal of its mean variation.

Tests of Structures

J. E. Howard (U. S.) reported briefly on the tests of complete structures which were begun by him several years ago and are now being continued under the jurisdiction of the Bureau of Standards. These tests are based on the use of his micrometer strain-gage, which permits of measuring deformations corresponding to stresses of less than 300 lb. per sq.in. In discussion Prof. A. N. Talbot (U. S.) referred to the use of the Berry multiplying-lever extensometer, which has also been applied with some success for gagings of stresses in structures.

W. Misangyi (Hungary) treated of the differences between tenacious and plastic materials, and suggested that their characteristic marks should be determined in tests of materials.

Prof. A. Mesnager (France) gave a very instructive and concise review of polarized-light investigations of stress in transparent bodies. Of special interest in this connection is the fact that E. G. Coker (England) in Section B gave results of the application of this method to stresses in cement briquettes.

A number of resolutions proposed in Section C were rejected by the section without submission to the general session of the congress. One of these not noted above was a proposal by O. Hoffmann (Germany) that tests of elastic distortion be included regularly in strength tests of tile pipe. A proposal by C. M. Chapman (U. S.) that the Association proceed to the study of methods of preserving wood against decay, fungus and animal attack was also rejected.

Peat Fuel for Power—A paper on this subject was presented before the Belfast meeting of the British Institution of Mechanical Engineers in July, 1912. Data were given on the use of peat in gas producers and under boilers in the plant of Mr. Hamilton Robb, of Portadown, where large supplies of peat were convenient to the factory. This plant has been running since September, 1911, on this fuel, which is fired as it comes from the drying yard. On a test run of six hours' duration with a load of 250 b.hp. the peat consumption averaged 2.55 lb. per b.hp.-hr. with fuel containing 18.98% water. Both producers were running and the loads were considerably below the total capacity of the plant. This load can be safely carried with either producer working singly and the plant has so run for several days at a time. In November and December the fuel fed was extremely wet, estimated at at least 70% water, as the rainfall in these months was heavy and the fuel entirely exposed to the weather. The plant, however, worked just as well as with the drier peat.

The separation of tar from gas was the chief difficulty overcome. It was found better to rely on water sprays than a coke scrubber, as the latter rapidly clogged with tar. The main portion of the tar was thrown out into a tar sump by a centrifugal extractor, but unless the gases were subjected to a thorough washing and cooling it was found that certain portions got past into the gas engine. By carefully studying the precise amount of water necessary in the cooler to insure condensing the tar vapor before reaching the extractor, the amount of tar in the gas at the engines is very small and the valves need cleaning only once a week.

When first started, the plant and producers required a thorough cleaning once a week. At present they can be run for three weeks, although the weekly cleaning generally takes place as a matter of policy. The washing water now amounts to about 7 gal. per b.hp.-hr. The cost of running the factory on coal was about $155 per week, compared with $80 on peat, not allowing for extra labor. A sample of the peat contained 24.75% carbon, 55.17% volatile matter, 18.98% water, and 1.10% ash. An average sample of gas during a 10-hr. run with 26% moisture in the fuel showed 10.6% CO_2, 21% CO, 13% H_2, 3.7% CH_4, and a calorific value of 144 B.t.u. per cu.ft.

Special Signal Indications on the Metropolitan Ry., England

The Metropolitan Ry., of England, is one of the city and suburban rapid-transit lines of London, its city section being mainly underground. Within recent years it has been converted to electric traction. Its signal equipment has been reconstructed throughout, and includes the special features of automatic block signals, upper-quadrant indications and a three-position signal. The two last features are said to exist on no other English line. Particulars regarding them are taken from a paper by J. F. Gairns in the *Bulletin* of the International Railway Congress.

Automatic Signals with Left-hand Upper-quadrant Indications

The arms of semaphore signals in the United States are placed on the right hand of the posts, and until recent years the indications were given by movements in the lower quadrant; that is, at and below the horizontal position. The present tendency, however, is to give the indications in the upper quadrant; that is, at and above the horizontal position. On some electric interurban railways, however, the signal arms are on the left side of the post and move in the left-hand upper quadrant, in order to prevent them from being obscured by the posts supporting the trolley wires. The right-hand arrangement on steam railways has been used to avoid interference of the semaphore with the cars, but with the introduction of the upper-quadrant movement, the left-hand upper-quadrant arrangement has been advocated for steam-railway practice. There seems to be little prospect of this change being made.

On the continent of Europe, the upper-quadrant movement has been adopted extensively, but in England the lower-quadrant has been used invariably, in accordance with the requirements of the Board of Trade. In that country the trains run left-handed and the semaphore arms are on the left of the post. In applying automatic block signals to a section of the Metropolitan Ry. it was found desirable to adopt the upper-quadrant arrangement, and this was approved by the Board of Trade.

It is stated by Mr. Gairns that the advantages of the upper-quadrant system are realized principally in connection with power operation and automatic signaling. It enables all mechanism between the motor and the semaphore arm to be eliminated, while in power signaling with lower-quadrant arms it is necessary to employ a certain amount of mechanism between the motors and the arms to insure a gravity return, unless all the weight necessary can be provided on the spectacle plate (or otherwise) on the other side of the fulcrum. Furthermore, the equipment can be made much lighter than heretofore, as the whole weight of the arm tends to cause return to the danger position, and there is no need to compensate for this nor to overcome the frictional resistance of rods and the possible clogging of guides and pivots. In addition, the shocks given to the post at each operation are reduced, and the power requirements are less, so that important economies in initial cost and in cost of operation and maintenance can be realized.

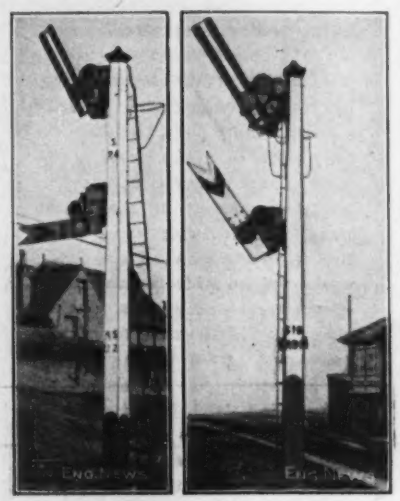


Fig. 1. Automatic Block Signals with Home and Distant Arms Moving in the Upper Left-Hand Quadrant; Metropolitan Ry. (England)

These signals are shown in Fig. 1, the post in each case having both a home and a distant arm. The same movements are used also for the arms on dwarf or ground signals.

Automatic Signals and Manual Interlocking Plants

At many of the stations, switches have to be operated more or less frequently, and therefore in most cases the signal cabins have been retained. For normal working, the manual levers are all thrown back and the signaling proceeds independently of the signalman, under the control of the trains themselves. When it is desired to operate switches, the signalman breaks into the system by manipulating his levers, thus breaking all conflicting circuits and returning the signals concerned to danger. He has then complete control of the required movements until he returns the levers to their normal positions, thus restoring automatic working. All circuits are carried through the levers concerned, and rail contacts insure that a train is protected until it has passed a sufficient distance beyond each signal.

Three-position Signal

This should be more properly called a triple-indication signal, since it is composed of lamps and gives its indications by colors instead of by position. It is said to be the only three-indication signal in Great Britain. The three lamps show red, green and yellow lights, one above the other. The signal is installed at the Edgeward Road station (underground), and the arrangement is shown in Fig. 2.

Most of the traffic consists of through trains and as the special signal *A* is located about half-way along the platform it acts as a platform "repeater" of the starting signal, *B*, its indications being then orange and green. There are, however, certain trains which terminate at this station, and these are diverted from the westbound track to a stub track, from which they cross to the eastbound platform track. As they are short trains, they stop before reaching the signal on the westbound platform, this signal being opposite the Y which connects the stub (middle) track with the through tracks on either side.

When one of these trains arrives, the three-position signal *A* is altered to red, the starting signal (which does not now apply) being placed at danger, irrespective of what its position would be under automatic working. The train is then admitted to the stub track under the control of the small lamp signal, *C*, which has only red and green indications. By this means the principles of signaling are maintained, for although it might not matter what indication was given by the three-position signal, there would be some contradiction in the provision of a "caution" indication by one signal controlling the through route, while a "clear" indication for the terminal siding is given by another signal.

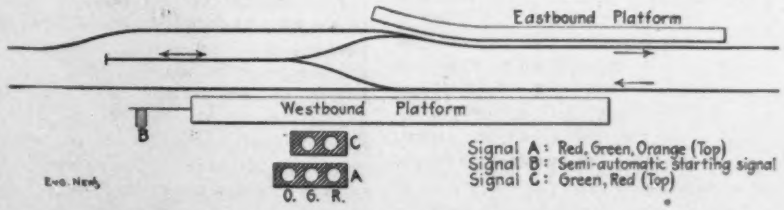


Fig. 2. Special Triple-Indication Lamp Signal at Edgeware Road Station (Underground); Metropolitan Ry., Ry., London, England

The Port and Harbor of Havre (France)

The general design and the engineering works of European ports differ, as a rule, very considerably from works incident to harbors and port development in this country. In this article we describe the development and the modern engineering works of a great French port, the most recent of these works being established (and under construction) on a great area of made-land along the foreshore, no other site being available. These latest works will provide for vessels of enormous size, and give a depth of about 40 ft. of water along the quays or wharves, while they will be accessible at all times, no locks being used, in spite of the fact that there is a variation of nearly 27 ft. between high and low tide level. Features of special interest are commented upon in our editorial columns.

The port of Havre is one of the oldest and the most important on the Atlantic coast of France, and that a natural harbor exists here is indicated by its name: Le Havre (the harbor). The development of the port and the harbor facilities as a matter of engineering presents many features of interest. In regard to its modern commerce, the number of ships entering and leaving increased from 11,420 (with a tonnage of 2,768,563) in 1870, to 12,460 ships (9,129,798 tons) in 1908. The relation of numbers to tonnage is an indication of the great increase in size of vessels. The freight and passenger traffic increased from 3,198,000 tons and 525,190 passengers in 1904, to 3,850,000 tons and 551,200 passengers in 1908.

The port is situated on the north side of a bay forming the estuary of the river Seine, the town being at the foot of the cliffs forming the coast line. The formation beyond the cliffs is alluvial, consisting partly of sandy loam and partly of fine sand mixed with boulders, while the surface is largely covered with pebbles and boulders.

The tidal conditions are peculiar. The flood tide occupies about 4¼ hr., while the ebb takes about 7¾ hr., and at half-flood the tide rises sometimes 3.28 ft. in 15 min. Owing to the shape of the bay there is a prolonged period of slack-water at high tide. The tide flowing in from the Atlantic forms two distinct tidal rises; one is directed straight across the bay to Havre, while the other follows around the south (protected) side of the bay, reaching Havre at such a period as to supplement or follow the former; observations show a second high tide just as the first begins to ebb. Owing to this phenomenon, high water is maintained for about three hours. Thus the actual flood period is about three hours; followed by high water for three hours, and then the ebb for six hours. This condition is very favorable to the port, giving an unusually long period available for the movements of vessels.* The range of tide is about 26¾ ft., with a maximum record of 30 ft. (Jan. 23, 1890).

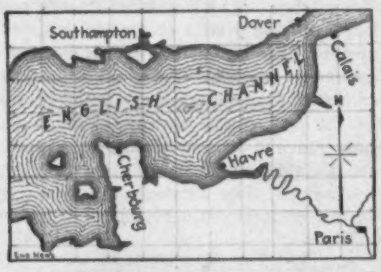


FIG. 1. MAP SHOWING LOCATION OF THE PORT OF HAVRE (FRANCE) IN RELATION TO THE PECULIAR TIDAL CONDITIONS OF THE ESTUARY OF THE RIVER SEINE

(It shows also the position of Southampton in relation to its own peculiar tidal conditions.)

DEVELOPMENTS FROM 1517 TO 1895

The port of Havre was established in 1517 as a naval and commercial port, the first works being on the water front of a small bay, with two short jetties extending into the sea. Vessels rested on the mud at low tide. In 1628, Cardinal Richelieu built the King's Dock, for the construction of warships, forming this at the head of a small inlet, and in 1667 this was closed by a dam with a lock connecting it with the bay, so as to form a closed basin or floating dock. It was about 525 ft. long, and from 114 to 360 ft. wide. In 1780, a bold project was

*The same phenomenon occurs at Southampton, England (see Fig. 1). Here the main tide flows in from the open sea, but the tidal flow through the channel (called the Solent) between the Isle of Wight and the mainland is checked by this narrow channel so that it does not reach Southampton until after the main tide. As a result of this, the period of high water at the port continues for nearly four hours at each tide.

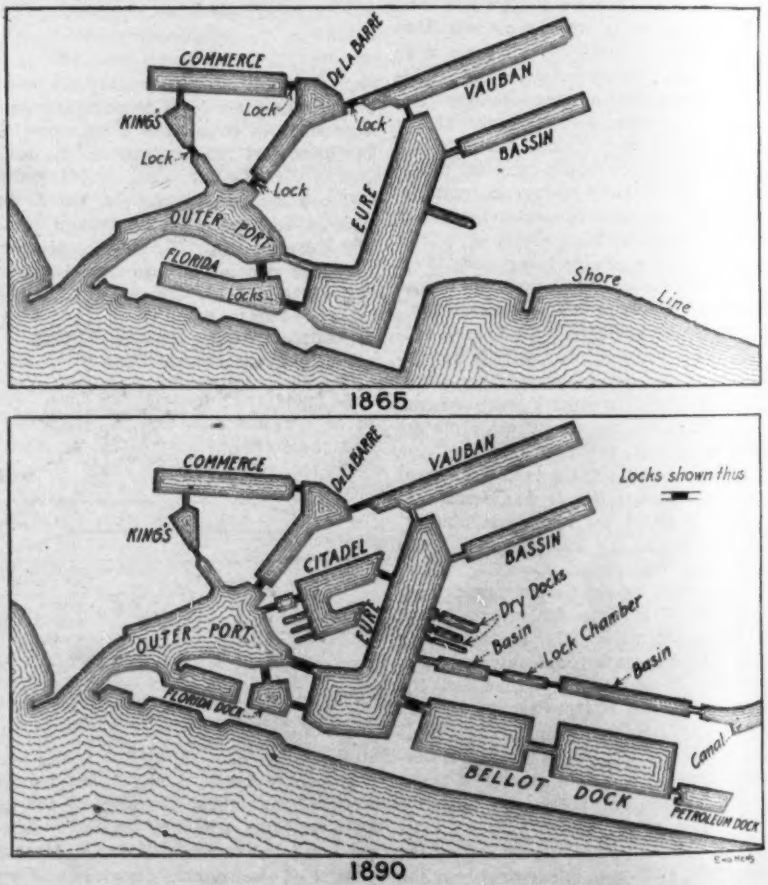


FIG. 2. PLANS OF THE DOCKS AND HARBOR OF HAVRE IN 1865 AND 1890

proposed providing for the construction of two large docks (the De la Barre Dock and the Commercial Dock) and the extension of the entrance jetties. These works were completed in 1838 and the docks were respectively 1843 and 1476 ft. long; the former had a width of 315 ft., and the latter 275 ft. for two-thirds of its length, enlarging then to 804 ft. at its lock connection with the other basin. In 1837 the Vauban Dock was commenced, and also the Florida Dock, the latter (460 ft. wide) being used for the first transatlantic steamers.

The Eure Dock was built between 1844 and 1855, and was followed by the dry dock and a main entrance lock for transatlantic steamers. The Bassin Dock was finished in 1859, and all these works were completed by 1865. By good fortune the Eure docks all the available land had been utilized, and later works have been formed by filling in along the shore. An exception to this is the Citadel Dock, which occupies the site of the old castle; this has two entrances (one being a lock chamber 262 ft. long and the other a single-gate channel), and three small dry docks for repair work. The conditions of 1865 are shown in Fig. 2.

In 1879, a law was passed permitting the extension of the port facilities by the construction of the great Bellot Dock. This opens from the Eure Dock and has two basins (each 721x1640 ft.) and a lock chamber 98½ ft. wide. This law provided also for two new dry docks alongside that of the Eure Dock. The walls for this new dock were not built on the firm sand bed in which all the

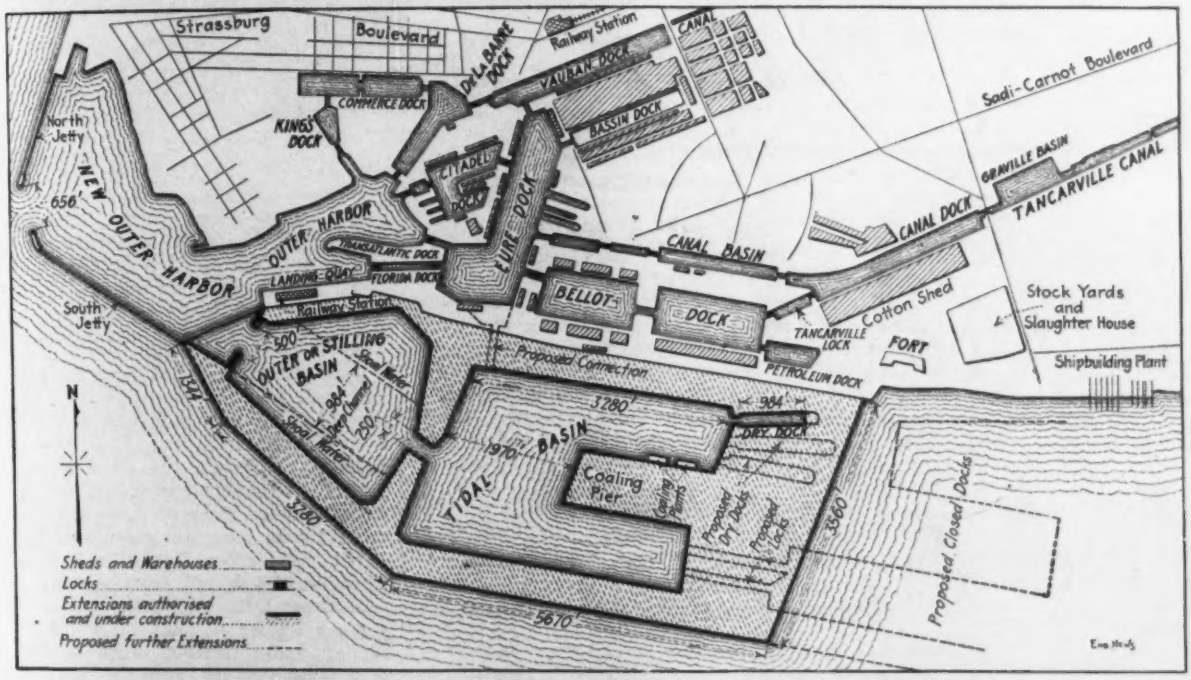


FIG. 3. PLAN OF THE PRESENT DOCKS AND HARBOR OF HAVRE, SHOWING THE EXTENSIVE WORKS NOW UNDER CONSTRUCTION ON RECLAIMED LAND IN THE OPEN BAY

Eure Dock was built at a time when ocean steamers were propelled by side wheels, and consequently a width of 100 ft. was given to the lock and to the entrance of the dry dock. The dimensions and shape of this dock permitted handling ships of over 650 ft. in length, and as the long period of slackwater at high tide permitted the use of a single pair of lock gates (without a lock chamber) ships of any length could enter. The far-sighted designers also gave the lock a depth unprecedented at that time, and as a result of these conditions the Eure Dock was able to accommodate the transatlantic steamers for more than 50 years, with no other work than careful dredging to increase the depth along the sides. With the completion of the Florida and other works were founded. The works were protected by embankments built along the shore so as to reclaim all the stretch of land from the Eure Dock to the Tancarville canal (noted below). With these works finished, about 1890, the port was as shown in the lower plan in Fig. 2, and a comparison of the two plans for 1865 and 1890 will show the extension of the shore line into the bay to provide room for the new Bellot Dock.

In 1895, another great project was put forward and authorized by the government. This included the following features: (1) the formation of a new tidal basin or outer port by means of two jetties, with an opening 656 ft. wide between their outer ends, and the dredging of this basin and its approach channel to an ample depth; (2) the construction within this basin of a steamship landing quay for the use of vessels touching at this port, the quay being 1640 ft. long, with 30 ft. of water alongside; (3) the construction of a lock basin (called the Florida lock), 98½x787 ft., to connect with the Eure Dock, and to provide for transatlantic steamers of the largest size and deepest draft. This lock is 790 ft. long (between gates) and 98½ ft. wide, and its sill is 14¼ ft. below datum, or 16½ ft. below the level of low tide. To ensure quick work in operating the lock, there are two arched culverts in each side wall, with lateral openings into the lock chamber. It was considered that bottom openings would cause too great a disturbance of water in the chamber. Each culvert has a cross-sectional area of 86 sq.ft. It will be seen that this lock occupies the site of the old Florida Dock.

These works have now been completed, and a comparison of Figs. 2 and 3 will show their great importance. Auxiliary to them is a large lock connecting the Bellot Dock with the Tancarville canal, beyond which the canal is widened to 328 ft. for a distance of ½ mile to form a regulating basin.

NEW TIDAL BASIN

In spite of all these works, the traffic of the port has more than kept pace with them, and a project was advanced for increasing the berthing accommodation by extending the Eure Dock to the south, on reclaimed land. But about this time

there began the very marked increase in size of steamers for the transatlantic service, and consideration of this led to a change in the plans. The French Transatlantic line had vessels 656 ft. long and was building one of 720 ft., but this latter was the largest which the port of Havre could accommodate, and even that could not be dry-docked. The construction of special works adapted to very large vessels was seen to be necessary, and would be of advantage also in releasing some of the existing berthing space for use by ordinary vessels. The regular fast service between Havre and New York requires five steamers, three of which may be in the home port at one time, so that about 3300 ft. of quay frontage would be required. The enlargement of the Eure Dock would not have met the requirements, and to provide the necessary berth accommodation and the great dry dock, it was necessary to provide a new dock or basin, and this as near the entrance of the port as possible.

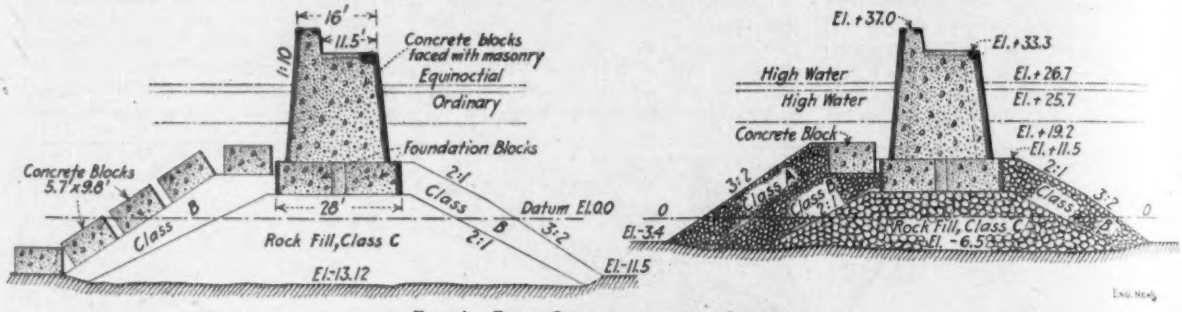


FIG. 4. CROSS-SECTIONS OF THE JETTIES

The first consideration was whether the new basin should be a closed dock or a tidal basin. For the former it was claimed that it would be the more easily operated, since the variation of water level need be only 20 to 24 in. instead of 26.75 ft. for the latter; also, the quay walls would be of less height and there would be no waves in the dock. Besides this, it would be more easily connected with the other parts of the port, and it could be maintained and kept clear of sediment at much less cost.

For the tidal basin, on the other hand, the arguments were in brief as follows: (1) the range of water level is relatively of small importance for the great passenger steamers carrying only a few hundred tons of cargo; (2) the connection with the rest of the port is easy enough, since the lock gates can be kept open for about three hours at each high tide (owing to the peculiar tide conditions noted already); (3) there is little silting in the port; (4) the high cost of the large sea-wall and quay of an open basin would be compensated by eliminating the expense of an enormous entrance lock (which lock was estimated at $6,000,000); and (5) ships could enter and leave the open basin at any time and at ordinary speed, without the delay (and possible danger) of passing through a lock. The arguments were concluded to be largely in favor of the open tidal basin. This project was authorized by the French government in 1909, and is indicated by the heavy black line and shaded area in Fig. 3. All the works are on reclaimed land, necessitating the construction of nearly three miles of protective embankment as a preliminary.

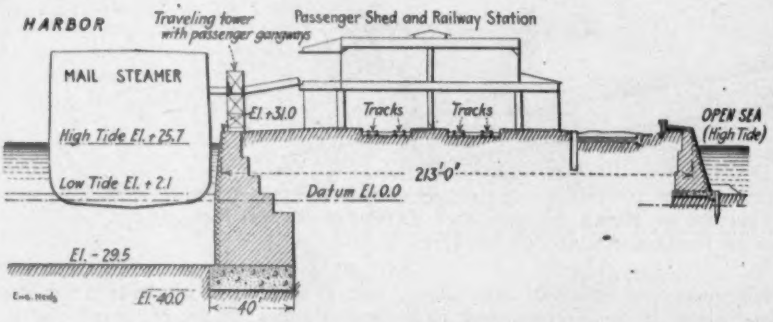


FIG. 5. CROSS-SECTION OF PIER AND LANDING QUAY FOR LARGE STEAMERS

The plans adopted provide for a tidal basin capable of providing about three miles of quay wall of great depth, but the north quay of which would be only about 3280 ft. long. This basin has been so designed as to permit the handling and maneuvering of the largest ships, and it presents opposite the entrance channel a width of 1968 ft. Its east end comprises two separate sections or basins, each about 984 ft. wide, with a length of 3600 ft. for the north and 4300 for the south section; between the sections is a dividing wall or quay about 820 ft. wide. The excavation will be carried to 39.36 ft. along the walls, but only 20 ft. for the remainder of the space, leaving the deepening to be done by the port dredges after the completion of the works. On the south side of the north section will be two coaling plants for handling rapidly the enormous amount of coal required by large steamers; a coal-storage plant will occupy the central quay or pier. Opening from the north section will be a dry dock for vessels up to 984 ft., and an increase in length to accommodate ships up to 1115 ft. is provided for. It will be able to take at any stage of the tide a vessel drawing 42½ ft. of water over a width of 120 ft. at midship section.

One difficulty which still remained was the avoidance of waves and swells in an open basin communicating with the great area of the outer harbor. To check the agitation and create still water at the berths, an intermediate or stilling basin is placed between the main basin and the area of open water (or outer port) inclosed by the jetties. This stilling basin is to be dredged to full depth only for a wide channel through it, the shallower portions tending to check the transmission of wave movements. A passage 250 ft. wide connects the two basins, and two short piers at the connection with the outer port limit this entrance to 500 ft. in width. Thus the channel from the open sea is interrupted by three passages of 656 ft., 500 ft. and 250 ft., respectively. A portion of the sides of the wider spaces will be revetted slopes in shallow water, so that it is expected the swell from the sea will be deadened, even in bad weather.

Some objection to this stilling basin was made on account of the additional cost, but the maritime interests insisted upon it, and pointed out that if experience should show that the water in it remains calm it can be utilized for berth accommodation. Besides, if a closed basin had been adopted it would have been dangerous to put the entrance of a lock (with gates 130 ft. wide and 65½ ft. high) on an outer port where the swell is sometimes very high and the tide

may rise 3 ft. in a few minutes (as noted already). To do this would involve the risk of having to keep the lock closed at certain periods of bad weather, due to the danger of operating the gates in rough water. All the foundations are built for an ultimate depth of 40 ft. of water, and the height of the walls and other works in many places is nearly 100 ft. The completion of this project will give Havre the very exceptional feature of

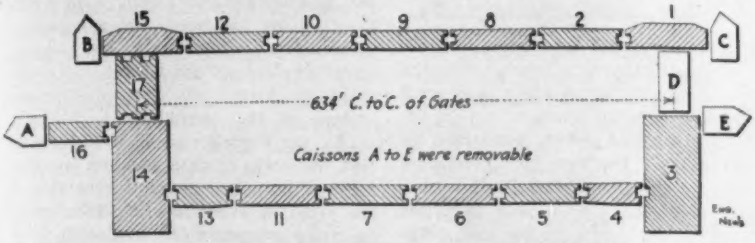


FIG. 6. PLAN OF FOUNDATION CAISSONS FOR THE BELLOT-TANCARVILLE SHIP LOCK AT HAVRE, FRANCE

being accessible at all times to ships drawing as much as 42 ft. of water.

JETTIES

The jetties inclosing the new outer port or harbor are massive masonry piers founded on beds of loose rock, and in deep water the slope of this rock on the sea side is covered by huge blocks of concrete to prevent displacement. The general type of cross-section is shown in Fig. 4. After the foundation stone had been allowed to settle, the surface was leveled and upon it were laid 62-ton foundation blocks about 13x10½x6½ ft. These were handled by a special floating crane. The blocks were made on a stretch of made-land filled for this purpose inside the land end of the north jetty. The stone used for the rock-fill foundation is of three classes: A, blocks of 88 to 2200 lb., averaging 440 lb.; B, blocks of 1 to 5 tons; C, blocks of 5 to 7 tons. The sides of the main part or superstructure of the jetties have a batter of 1:10.

The head of each jetty, however, has a foundation caisson about 100x52 ft., the length being such that the outer end is beyond the toe of the slope of broken stone. Thus the channel between the heads can be dredged to full depth for the entire width, and there will be no fear of ships grounding on the rock-fill of the jetty, as in the case of the disastrous wreck of the steamer "Berlin" at the Hook-of-Holland a few years ago. The caissons are made 52 ft. wide so that the pier head can accommodate not only a lighthouse and signals but also a gun battery. The total length of the jetties is 5658 ft., of which 200 ft. are on pneumatic caissons. The cost averaged $433 per lin.ft.

LANDING QUAY

The landing quay for ocean passenger steamers is in the outer harbor, and is mainly for the use of vessels touching at the port and wishing to avoid the delay and expense incurred in entering the docks. It enables the transatlantic steamers also to land passengers directly at any stage of the tide. Its length is about 1640 ft. The base of the quay wall on the harbor side is on a bed of firm sand and gravel, and at a depth of 41 ft. below low water. It is a solid mass of concrete 39½ ft. wide at the base, and with a batter of 1:20 in the lower part and 1:10 above. The faces are of cut stone 4½ ft. wide. The foundations consist of 14 pneumatic caissons 115 to 130 ft. long. The caissons were about 20 in. apart, and the opposite faces of each had a rectangular recess 16½ ft. wide and 4 ft. deep. The 20-in. space was closed by sheet piling 20 in. beyond the recesses, and the entire space was then filled with concrete, forming a key block. The sea side of the quay is formed by a smaller wall. The total width of the quay is 213 ft. and on it is erected a steel-frame building, with accommodations for passengers, customs officers, railway station and tracks, etc. Fig. 5 is a cross-section of this quay or pier.

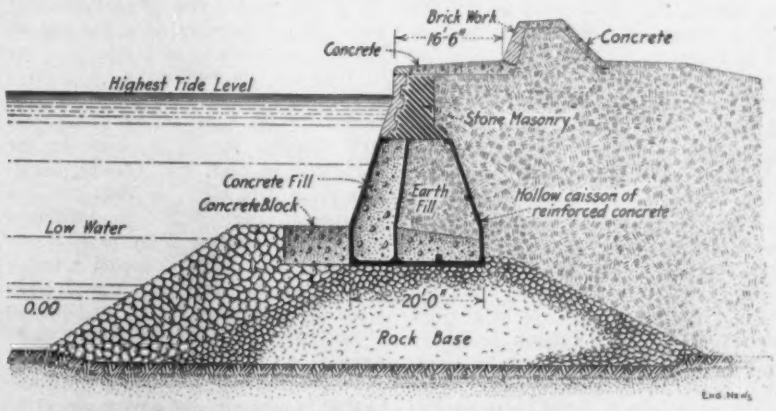


FIG. 7. CROSS-SECTION OF SEA WALL WITH FOUNDATIONS OF HOLLOW REINFORCED-CONCRETE CAISSONS

THE TANCARVILLE CANAL AND BASINS

This canal, mentioned above, was authorized in 1880 to enable barges and small vessels to pass between the port of Havre and the River Seine without crossing the open bay, and also to connect the port with the extensive system of inland navigation. The length of the canal is 15 miles and it has a lock at each end. The depth of water is 19.6 ft. from Havre to a short branch leading to the small inland port of Harfleur, and this branch is of the same depth, in order to permit the use of vessels drawing 18 ft. of water to serve the smaller port and the several industrial establishments along this part of the canal. Beyond this branch, to the river lock at Tancarville, the depth of water is 11½ ft. The width of the canal is 62.3 ft. from Havre to Harfleur, and 72 ft. thence to Tancarville. The lock chambers are 98½x590 ft., with entrances 52 ft. wide.

Berth accommodation for vessels is provided by two docks or basins on the canal at Havre, the outer one having communication with the Eure Dock by means of a lock. In these basins, cargo can be transferred directly between ships and barges. To enable the larger basin (or Canal Dock) to be used by vessels larger than could enter through the canal lock from the Eure Dock, a ship lock connecting with the Bellot Dock was authorized in 1904, and this was completed in 1910. The distance being short, and it being desirable to obtain the greatest possible working length, rolling gates (traveling at right angles to the lock) were used instead of the ordinary swinging gates. Each gate is carried on two pair of wheels at each end.* The clear length of the lock between gates is 606 ft.; the width is 100 ft. at top and 85 ft. at the bottom. The head and side walls are founded on 16 large caissons, while the heads of the entrance walls and the floor of the east entrance were built within movable caissons. The arrangement of the caissons is shown in Fig. 6, and it will be seen that they have recesses in the adjacent walls for connect-

*Lock gates of this kind have been described in Engineering News as follows: Rolling gate for Lock No. 37 on the Ohio River at Cincinnati, March 4, 1909; sliding gate for lock connecting old and new docks at Avonmouth (England), April 28, 1910.

ing or key blocks, as already described for the landing quay. Most of the caissons were 23x102 ft., but the large one at each end was 68x138 ft.

The Canal Dock is used specially for steamers bringing cotton, the imports of which at Havre amount to about a million bales annually. The length of the south quay front is 2775 ft. and just back of it is a steel-frame shed 2090x375 ft. with 18 electric unloading cranes on the space between the shed and the edge of the quay. At the rear of the shed is a platform for loading the bales into railway cars, and this is served by locomotive cranes. The steel columns are spaced 61 ft. longitudinally and 46 ft. transversely. Further east along the canal is the Graville Basin.

Present Work

The works now under construction include the following: 1, the bulkhead wall or sea-wall extending from the end of the existing south jetty and then back to the existing shore line (near the Petroleum Dock), thus inclosing the site for the new dock; 2, the 3300-ft. north quay or dock wall of the new basin; 3, the 984-ft. dry dock. It is expected that these will be completed by 1918.

For the sea-wall extending along the line of the intermediate or stilling basin there is a foundation bed of loose rock about 26 ft. wide on top, having embedded in the top (near the outer edge) a row of 35-ton concrete blocks 10 ft. wide and 6 ft. thick. This is shown in the section, Fig. 7. Directly behind this line of blocks are sunk hollow caissons of reinforced concrete, which are built on shore and floated into position. These caissons are 82 ft. long and 19 ft. high; the width is 20 ft. at the base and continues for a height of 6 ft., above which the sides slope inward to a top width of 11 ft. An 8-in. space is left between the ends of adjacent caissons, to be filled later with concrete. The caissons are launched when 20 days old in summer, or 25 days in winter, being ballasted by a bed of concrete to give the desired draft. Each caisson is divided into two rows of compartments by a central longitudinal partition and seven transverse partitions. The compartments on the outer (or sea) side are filled with concrete; while the inner ones are filled with excavated material. Upon the caissons is built a wall of stone masonry, 6 ft. wide on top, and faced with brickwork on the (inclined) outer face. Filling is deposited on the inner side of the line of caissons, and is capped with a concrete walk 16½ ft. wide from the stone coping of the wall. On the shore side of this walk is a bank faced with brickwork and concrete, as shown.

The continuation of this sea-wall, forming the outer side of the floating basin, is of slightly different construction, the caissons being founded on a bed of sand and gravel deposited by dredges. At the toe of the caissons is a line of piles and sheet-piling, the top of which is covered by a rock fill, while concrete is filled between the caissons and the projecting top of the piling. The east wall (returning to the present shore line) is of a temporary character, with a view to future extensions. It has a timber crib bulkhead with earth filling behind it.

DIMENSIONS OF DOCKS OR BASINS AT HAVRE (FRANCE)

Dock	Length Ft.	Width Ft.
King's	525	115 to 360
Commerce, east	1843	315
Commerce, west	1843	315
De la Barre	1476	262 to 803
Vauban	2680	328
Bassin	1826	262
Eure, south	3093	656
Eure, north	3093	1187
Citadel	1181 to 574	262 to 360
Bellot, west	3100	722
Bellot, east	3100	722
Petroleum	777 & 705	230
Canal	3150	147 & 387

The two short jetties at the channel between the outer harbor and the stilling basin are of stone masonry, and have the outer portions built on pneumatic caissons. The north jetty has three of these caissons: 27x28¼ ft.; 77x21¼ ft., and 60x16½ ft., the first of these (carrying the jetty head) is sunk to a depth of 33¼ ft. below the bottom of the channel or 83 ft. below the level of maximum high water. The top of the jetty head is 7 ft. above that level, while the main body of the jetty is only 3.24 ft. above the same level. The jetties are 10 ft. wide on top, which is increased to 21.3 ft. at the head. The inner portion of each jetty is founded on a flat bed of concrete protected on each side by a line of piles and sheet-piling.

The north quay wall of the floating basin will be built on 18 rectangular steel caissons 141x46 ft., sunk by the pneumatic process, the working chambers being 6 ft. high. In each end is a rectangular groove 4x16½ ft., forming a key for the concrete filling between the caissons. This filling is placed within a portable caisson dropped vertically into place. Each caisson has an air lock and a concrete shaft. The dry dock will be founded on an immense steel caisson 1130x200 ft., built of steel girders embedded in concrete, and having the working chamber divided into compartments by deep girders forming partitions. It will have 86 air locks and 130 concrete shafts. The masonry walls will be kept 3¼ ft. above the water level.

Miscellaneous

The general dimensions of the ten main docks are given in the accompanying table. They have a water area of 200 acres, and a total water front of 7½ miles, while the area of the land spaces between and around them is about 120 acres. In the 30-year period from 1879 to 1909, the French government appropriated in all about $34,000,000 for work at Havre, and about $20,000,000 have been spent. This does not represent the total amount spent in the improvement of the port, which would include the large sums provided by the Chamber of Commerce for the necessary equipment: cranes, warehouses, etc. These expenditures for the same period are estimated at nearly $2,000,000.

The bulk of the information given above is condensed from articles by Mr. Guiffart and Mr. Dantin in *Le Genie Civil*. This has been supplemented by information furnished us by Mr. Jacquey, Chief Engineer of the Chamber of Commerce at Havre, which organization has charge of the operation of the port. Under the French system of administration, the works of extension and improvement of ports are executed according to the plans of and under the direction of the state or government engineers.

How the Chicago and Cleveland Street Railway Settlements are Working Out*

By Delos F. Wilcox†

There are many types of street-railway franchises in operation in the United States, but the only two cities which have thus far worked out general street-railway settlements of national importance and national interest are Chicago and Cleveland.

Chicago has an area of about 190 square miles and a population of 2,185,000, according to the last census. Cleveland is a much smaller city, having only a little over 40 square miles of area and a population of 560,000 in 1910. The two cities may be compared from a street-railway standpoint by stating that the total number of passengers carried on the surface street-car lines in Chicago is almost 600,000,000 a year, while in Cleveland the number is a little more than 200,000,000. The larger number of riders in Cleveland in proportion to population is accounted for partly by the fact that the elevated roads in Chicago handle a large part of the local passenger traffic, and partly by the fact that in Cleveland traffic has been stimulated by the lower fares. The relative magnitude of the two cities from the street-railway standpoint may also be seen from the fact that the recognized capital value of the Chicago systems on Feb. 1, 1912, was about $127,500,000, as against about $24,500,000 for the Cleveland property as of Feb. 29, 1912.

The Chicago settlement ordinances have been in operation for a little more than five years, and the Cleveland or-

*A paper read before the National Municipal League, Los Angeles, Calif., July 12, 1912.

†Chief of the Bureau of Franchises, Public Service Commission for the First District of New York, 150 Nassau St., New York City.

dinance for a little more than two years.‡ The practical administration of the Chicago ordinances has been under the direct supervision of Bion J. Arnold, who, aside from Walter L. Fisher, was the chief factor in the original negotiations. The administration of the Cleveland ordinance was for the first two years in the hands of a stranger. Both Tom L. Johnson and Judge Robert W. Tayler, the two men most responsible for the Cleveland settlement, died soon after the ordinance went into effect. Since Jan. 1, 1912, however, the administration of the ordinance has been in the hands of Newton D. Baker, now mayor of Cleveland, and Peter Witt, city street railroad commissioner, both of whom were trusted lieutenants of Tom Johnson.

The Chicago Settlement

The Chicago ordinances were the outgrowth of many years of financial exploitation, political corruption, intolerable service, stubbornly contested litigation and prolonged public agitation almost unparralleled in the history of American cities. During the preliminary period the people of Chicago became converted to the principle of municipal ownership, but found themselves so entangled in constitutional and statutory restrictions, so lost in administrative chaos, and so handicapped by the fag ends of unexpired privileges, that the great, rich city of Chicago could not, absolutely could not, buy up the antiquated junk which passed for a street-railway system and itself undertake to rehabilitate and build up a transportation utility worthy of a progressive city.

The city had statutory authority to acquire and operate street railways, but as finally interpreted by the Supreme Court of Illinois, this authority was subject to financial conditions which the city could not possibly fulfill. In other words, one law gave the city powers which other laws prevented it from exercising.

On the other side the franchises were expiring, and in a notable decision the United States Supreme Court definitely denied the companies' most important claims. Yet the companies were in possession of the streets, and the railways, wretched as they were, had to keep going.

A great city of two million people clamored angrily and persistently to be carried in decent cars at a reasonable speed. The great issue was better service, and municipal ownership as a means to get it. The deadlock could not continue.

Out of these impossible conditions strong men fashioned a compromise and drove it through. The city was unable legally and financially to get immediate municipal ownership, but it could not postpone any longer the immediate rehabilitation of the system and the service. The surface street railways of Chicago, barring certain comparatively unimportant outlying lines, were operated by two companies, which served separate districts, but had access in common to the business heart of the city. The settlement ordinances applied to both companies.

To smooth the way for municipal ownership, the existing properties were appraised and the value was written down in a book at the round figure of $50,000,000—$29,000,000 for one system and $21,000,000 for another. It was agreed that the new capital required for the reconstruction, reëquipment and extension of the lines should also be written down in the book from time to time and added to the original valuation. The sum as shown was to be the purchase price, and the city would have the option at the end of any period of six months to walk up to the counter, lay down the price, and walk off with the goods. All the uncertainties of future appraisals, litigation, corporate resistance and complex dispute were wiped out. The purchase price was fixed. City money, whenever it was forthcoming, would talk.

This particular option, however, would not be effective during the first period of 20 years, except for municipal operation, although if the city itself could not take over the property for municipal operation, it could organize a licensee company limited to a 5% profit, and the latter could take over the street railways to operate them as trustee for the city's benefit, by paying the same purchase price. Moreover, the city could designate as its licensee any properly authorized new company, not limited as to profits, and in that case the licensee could take over the property by paying the purchase price plus a bonus of 20%. After 20 years this bonus would not be required. In the meantime, the roads were to be rebuilt and reëquipped and not less than a specified minimum mileage of extensions was to be added each year.

A Board of Supervising Engineers, consisting of Mr. Arnold as chief engineer and chairman, a representative of the city, and a representative of the company in each case, was established, principally for the purpose of supervising the work of rehabilitation, certifying additions to capital, and determining what expenditures should be charged to the various accounts. On the companies' actual expenditures for capital account, they were to be allowed certain additional amounts—10% for contractor's profit and 5% for brokerage. Moreover, for the three-year period fixed as the period of "Immediate Rehabilitation" 70% of gross receipts was arbitrarily set aside for operating expenses, and it was provided that anything spent for renewals during this three-year period in excess of what might be available for that purpose out of this 70% should be added to capital.

Street-railway fares were fixed at 5c. for adults and 3c. for children between seven and twelve years of age. Children under seven, properly attended, were to be carried free. Except in the downtown business district, comprising an area of about ⅓ sq.mi., free transfers were to be given that would enable a passenger to ride from any point on either system to any other point on either system, not involving a return trip. Through routes were to be operated over both systems as listed in the ordinances. The companies were to be allowed 5% interest on the recognized capital value or purchase price as written down in the book. This allowance was to come after operating expenses, including maintenance, renewals, accident reserve and taxes. Specific percentages of revenues, subject to modification by the Board of Supervising Engineers, were to be set aside to insure the upkeep of the property to the highest practicable standard of efficiency.

After the companies had withdrawn their 5% return on capital, the net profits were to be divided in the ratio of 55% to the city and 45% to the companies. It was stipulated that the city's share of the profits should be placed in a fund for the purchase and construction of street railways. The expenses of the Board of Supervising Engineers were to be charged to capital account during the three-year period of immediate rehabilitation, and thereafter to operating expenses. Mr. Arnold's salary as chairman of the board was fixed at $15,000 a year, and he was allowed $15,000 a year additional as chief engineer during the period of reconstruction. In case the companies failed to comply with the provisions of the ordinances for a period of three months exclusive of time during which, without their connivance, they were delayed or interfered with by unavoidable accidents, labor strikes or court orders, their rights under the ordinances might be forfeited, but in any such case the rights of mortgagees to recover by foreclosure up to the full value of the property as reflected in the purchase price, were not to be affected. In other words, forfeiture would run against the operating companies, but not against their bondholders unless and to the extent that bonds had been issued in excess of the value of the property.

How has this scheme worked? Chicago has got a physically reconstructed, high-grade street-railway system. Practically all the small outlying lines have been brought into the scheme and are now being operated by one or the other of the two companies. This means a universal 5c. fare for adults and free trans-

‡Detailed accounts of the Chicago and Cleveland street railway settlements, preceded in each case by historical sketches, were published in our issue of March 10, 1910, pp. 267-72, and editorial comment on the settlements appeared on pp. 280-1 of the same issue.—Ed.

fers throughout the city, except in the downtown business district. This limitation of the transfer privilege was designed to prevent abuses. It operates to the inconvenience of a number of people who have to walk from a block or two to perhaps a third of a mile to reach their downtown destination, or else pay a second fare.

The through-route provisions of the ordinances have not yet been worked out satisfactorily, largely as a result of the jealousies and conflicts of interest of the two companies. Only 9% of the cars entering the business district are through routed, with the result that a passenger desiring to pass through the heart of the city must submit to considerable delay in waiting for a through car, or in making a detour by transfer around the business district, or must change companies and pay a second fare. Downtown traffic is badly congested, partly by reason of the fact that 91% of the cars switch back or go around short single-track loops, crossing and recrossing each other's routes with resultant confusion and delay. Service is generally good so far as physical equipment is concerned, but there are serious complaints of overcrowding during the rush hours. No trailers are used.

The original purchase price, including the smaller properties since brought under the ordinances, was $55,775,000. On Feb. 1, 1912, after five years, their aggregate purchase price was $127,492,398, an increase of 128%. During the five years period the companies had received about $22,000,000 as interest on their investment, $6,432,183 as their 45% of net profits, and about $9,000,000 as their percentages of profits on rehabilitation, a total of approximately $37,500,000, or the equivalent of 8.5% per annum on their investment as shown by the purchase price. During this same period taxes paid to the city and other public bodies amounted to about $4,800,000, and the city's share of profits amounted to 7,804,000.

The Chicago Settlement Ordinances are a great constructive work of municipal statesmanship. They are the practical outcome of the first big battle in this country to recover for a great city the control of its streets. In the light of Chicago's experience, many other battles will be fought before the cities of America have attained the complete ownership and control of their highways, which is, in my opinion, a prerequisite to the full realization of civic democracy—the assumption by the city of the self-control necessary to transform the cities in which a few of us now grow rich and many of us now grow poor into cities in which we all may *live a full and free life.*

Certain serious mistakes in Chicago's policy have been revealed as the result of five years' experience. The possibility of municipalization was intended as a check upon the companies. In fact, these ordinances were represented as giving them one last chance to make good as servants of the people, the sword of municipal ownership being suspended at all times above their bowed necks by a slender thread. In five years' time that slender thread has grown mighty stout, until timid capital all over the country is clamoring for a chance to bend its neck under a sword suspended by that kind of a string. While the city has been accumulating a purchase fund of about $8,000,000, the purchase price of the property has *increased* nearly $80,000,000, and the companies have been making 8% on that price. At this rate, Chicago will not be likely to continue long to regard as of great practical value the simple announcement of its famous contracts: "Just walk up with the money and you can walk off with the street railways."

The mistakes of the Chicago ordinances are mainly three:

(1) They permanently capitalize many millions of dollars of franchise values, superseded properties, city pavements and construction profits, which never should be capitalized at all except as a last resort, and in that case should be amortized out of earnings as a first charge after the payment of bare interest rates on the investment. It is impossible to tell from the figures available just how much of the present purchase price of the Chicago street railways represents *bona fide* present value of tangible property. I believe, however, that at least 20 or 25% of the purchase price represents elements that never should be permanently capitalized. In fact, it is fairly certain that in the process of rehabilitation, more *dead capital* has been added to the account than the entire accumulations of the city's purchase fund.

(2) The second mistake in the Chicago ordinances is their failure to provide for the investment of the city's purchase fund in the securities of the street-railway system. While the companies are pouring new millions of capital into car lines and getting 5% brokerage and 5% a year as a minimum return, the improvident city puts its money in the bank and gets 2¼% interest on it.

(3) The third serious mistake of the Chicago plan is the indefinite and inadequate provision for the permanent supervision of service by the Board of Supervising Engineers after the expiration of the reconstruction period. The ordinances are not very clear on this point, but the board is unquestionably very limited in its initiatory jurisdiction over service matters.

The Cleveland Settlement

Turning to Cleveland, we find a franchise settlement of another type. There, as in Chicago, the ordinance finally adopted was the outgrowth of years of litigation and political struggle. But in Cleveland the service had not been so badly neglected and the corrupting activities of the street-railway interests had not been so bold and brutal. The main struggle in Cleveland was for lower fares, with municipal ownership as soon as conservative Ohio would permit it.

Tom Johnson, as a practical railway man and a radical civic statesman combined, asserted the practicability of 3c. fares, and pending the working out of the municipal-ownership program, demanded politically that the street-railway company of Cleveland should be deprived of its monopoly profits. Unable to attain his purpose by negotiation, he did not hesitate to establish a competing line under franchises practically granted by himself to himself as trustee for the public.

My time does not permit of a review of Johnson's long fight. The settlement known as the Tayler ordinance was finally put through in the face of Mr. Johnson's personal opposition and went into effect March 1, 1910. Under this settlement the value of the property was agreed upon, as in Chicago, and provision was made for additions to capital account from time to time, subject to the city's approval. As yet Cleveland does not enjoy even the theoretical right to own and operate street railways,* but looking to the future, the ordinance reserves to the city the right, when it is legally competent, to take over the property at the recognized capital value plus a bonus of 10% on the portion of that value not represented by bonds.

The city is also authorized to designate a licensee company which will be permitted to acquire the property at the same price on condition that it will agree to accept a smaller return by at least ¼ of 1% on the portion of the capital value represented by capital stock than the original company is at the time entitled to receive. But the original company must be allowed to submit a bid before a licensee is designated, and no licensee may be designated unless it underbids the original company. At the expiration of the franchise or any renewal of it, the bonus will not be required as a part of the purchase price.

Aside from the provisions for purchase, the main idea of this ordinance is that the company shall receive a fixed rate of return upon its investment, and all surplus profits shall be prevented by an automatic readjustment of fares in accordance with a detailed schedule in the ordinance itself, which provides for a range between a maximum rate of 4c. cash fare, seven tickets for a quarter, and 1c. for a transfer, without rebate, to a minimum rate of 2c. cash fare, 1c. for

*One of the constitutional amendments adopted in Ohio, on Sept. 3, 1912, was designed to clear the way for municipal ownership of any franchise utility by any city of the state.

a transfer and 1c. rebate when the transfer is used. Between these extremes are eight intermediate variations in the rates. When the ordinance went into effect, the rate was to be 3c. cash fare, 1c. for a transfer and no rebate.

A certain fund was established to operare as the financial pulse of the street-railway system. This fund was started off at $500,000, and it was provided that whenever the fund increased beyond $700,000, the fares should automatically be lowered, and whenever the fund went below $300,000, the fares should be raised. In case of dispute between the city and the company about the necessity of a change of fare other than by this automatic arrangement the matter was to be submitted to arbitration. But in case the city ever let the franchise come within 15 years of expiration, the company would be entitled to charge the maximum rate provided for in the schedule, and apply all surplus profits to a reduction of capital, which would, in case of subsequent purchase by the city, go to reduce the purchase price. The company was allowed a fixed amount, 11½c. per active car mile of motor cars and 60% as much per car mile of trailers for operating expense, and also a fixed amount per car mile for maintenance, renewals and depreciation. This latter allowance varies with the season, but verages about 5c. per car mile. These llowances may be changed by agreement or by arbitration. The company is allowed to withdraw each year from the interest fund a sum equal to 6% on its authorized capital stock and actual interest charges not exceeding 6% on its bonds. New stocks and bonds may be issued, but unless approved by the city, they do not become a part of capital value.

The city appoints a street-railroad commissioner whose offices and supplies are furnished and whose expenses and salary are paid by the company as an operating expense. The amount of the commissioner's salary is limited to $12,000 a year. The present commissioner gets $7500, the same as the heads of other city departments. The expenditures for salaries of the commissioner and his assistants are limited to 1% of the company's "operating" allowance in any one month, except that in checking construction accounts the commissioner may spend also not exceeding 1% of the estimated cost of the proposed additions, extensions and betterments. The commissioner is the technical adviser of the city council. He has very little ultimate authority of his own except in the way of examination into the company's accounts and practices. Backed by the city council, however, he has absolute control of car schedules and service. Nearly every other question of dispute between the city and the company may be referred to arbitration.

On Mar. 1, 1910, the new plan started off with 3c. cash fares and a penny for a transfer with no rebate. The company has spent more than the ordinance allowance both for operation and for renewals. But the overdrafts in the funds, until authorized by the city or by arbitrators, do not affect the interest fund, which determines the fare. On June 1, 1911, the interest fund having passed the $700,000 mark, the fare was reduced one notch to 3c., with penny-for-a-transfer and a penny-rebate. That is practically 3c. straight, as the thrifty Clevelanders do not buy transfers unless they are sure of using them, in which case they get their money back. A passenger may buy five tickets for 15c., but unless he does buy tickets, he must present the exact change, three pennies for one ride, or 6c. for two, or the company will keep his nickel. In practice a little more than 1% of the rides are at the nickel rate. From June 1, 1911, to the present time (July, 1912), the 3c. fare has been maintained. This is in spite of a deficit in the operating and renewal funds.

For a period of eight months in 1911, the city allowed the company an extra cent per car mile for operation. Otherwise the allowances have been as set forth in the ordinance. During the first year the company spent and took about $199,000 more than the gross receipts and during the second year about $362,000, making the gross deficit for the two years about $561,000. That is practically equivalent to the penny-for-a-transfer charge for one year. It should also be noted that the city fare is maintained to the suburb of East Cleveland under an old franchise requirement at a heavy annual loss, estimated by the city at not less than $300,000. In Cleveland, when tracks, cars, etc., are replaced, their full original cost is charged to maintenance, while in Chicago only the original appraised value is so charged.

Cleveland is getting fair service at a 3c. rate. It may be that the increase in traffic will overcome the deficits thus far accrued. The City Street Railroad Commissioner has ordered 100 new 55-ft. inside measurement trailer cars to cut down operating expenses and relieve the rush-hour traffic. Gross receipts in April, 1912, were about $4000 greater than in April, 1911, in spite of the lower rate of fare which represented a loss of approximately $50,000 revenue.

In Cleveland, the city has the right to designate and order improvements to the amount of $2,500,000, which are to be made this year and next. Extensions, betterments and improvements generally may be ordered by the city, and the company must make them, if it can, acting in good faith, secure the funds, unless it claims that the proposed expenditures will impair the future ability of the property to earn the stipulated return on investment. In that case the matter goes to arbitration. The city cannot, however, propose any improvements after it has let the franchise come within 15 years of expiration. Improvements proposed by the company may be made if approved by the city.

General Conclusions

Cleveland has made the same mistake as Chicago in permanently capitalizing franchise and pavement value, and making no provision for reduction of capital, except during the 15-year period prior to the expiration of the franchise. The people are being saved a lot of money. The company's motive for economy is destroyed, but thus far expenditures are being pretty well held in check by the arbitrary provisions of the ordinance and the supervising alertness of the city commissioner and the city council. It is reasonably certain that in spite of its low fare and no profits, Cleveland will not have any harder time than Chicago in buying out the local street-railway system.

The experience of the two cities points to one conclusion, namely, that if municipalization is to be either actual or potential, all franchise values and superseded and imaginary property must be wiped out of the permanent capital account. If this is done and a city wishes to municipalize, it can do so by requiring the property to pay for itself out of earnings. The increased safety of the investment will alone pretty nearly supply the amortization fund without any higher fares. This seems to be the only practicable plan of municipalization that does not involve the assumption by the city of enormous additional debts.

No Guarantees in Schenectady Paving Contracts—Mr. Mullen (Commissioner of Public Works) explained some of the ruses worked by contractors to exact high prices from city administrations. One of the most prominent of these schemes in the so called "guarantee clause" in the contracts which might be all right except that it is very costly and doesn't guarantee anything. He showed that such a "guarantee" was actually illegal as the law distinctly puts it up to the abutting property holder to pay the first cost of paving and up to the city to maintain the repairs. Thus it is next to impossible to collect anything from "guaranteed" work and this only when some flaw in the work can actually be shown. In the uptodate paving system no such guarantee is demanded, but an "estoppel clause" makes it possible to compel the contractors to make good any actual violation of the specifications any time within 20 years. The contractors and the surety companies have naturally boosted the guarantee clause. It means that an excess charge can be mulcted from the administration ostensibly to cover the cost guarantee, and every charge of the kind opens up new possibilities for new margins of profit.—(From an account of proceedings of the Schenectady City Council in the Schenectady "Citizen," of Aug. 30.

Sewage Treatment at Mt. Vernon, N. Y.

By Charles A. Hammond*

The sewage treatment works at Mount Vernon, N. Y., include settling or septic tanks, sludge beds, sprinkling or percolating filters with overhead nozzles delivering vertical streams to sprayers of the splash plate type and a final settling basin. The septic tanks sludge beds and filters are covered. The tanks and filters are connected to ventilating and deodorizing towers. The author, who was connected with the design and construction of the works and was also in charge of their operation for a considerable period, describes the works and presents some of the operating results.

*Civil Engineer, 301 S. Fourth Ave., Mt. Vernon, N. Y.

The sewage-treatment works of Mount Vernon, N. Y., came into existence as the result of a judgment of court compelling the city to discontinue the nuisance caused by the discharge of its sewage into the Hutchinson River, a small stream forming the eastern boundary of Mount Vernon, the lower part of the river ending in a tidal estuary known as Eastchester Creek. With the exception of a small strip of territory on the westerly side of Mount Vernon, along the left and steeply sloping bank or watershed of the Bronx River, the entire area of the city slopes generally toward the Hutchinson River and Eastchester Creek; thus, all the trunk-sewers naturally were laid in that direction, the sewage from the Bronx River section (which is eventually expected to enter the Bronx Valley sewer) being now pumped over the divide into the head of the principal trunk-sewer flowing eastward.

The usual non-action on the part of the city authorities followed the court-order; then an extension of time was asked for and granted. Further delays occurred, until, after sharp reminders from the state commissioner of health, the matter was definitely referred by the city council to its special committee on sewage disposal. The first year, this committee took no action; but, finally, during the following administration, a contract was made with John M. Farley (who had furnished plans for a contact-system for Ballston Spa), to prepare plans for a purification plant. Geo. L. Robinson (who had been associated with Mr. Farley in the Ballston Spa Work), was called in consultation, and to him and the writer (designing engineer for Mr. Farley) the immediate preparation of the plans was intrusted. Later, the writer became resident engineer in charge of the execution of the work, the contract for which was awarded to the Bunting-Bull Co., who started construction in October, 1908, and finished in the spring of 1910. Still later, the writer was placed in charge of the operation of the works.

Some years ago the city of Mount Vernon purchased about 13 acres of land, adjoining the Hutchinson River, to be used for a disposal plant. Although some of this land was afterward sold for a railroad right-of-way, what was left was admirably adapted for the purpose, but in view of the limited area available it was wisely decided to adopt a sprinkling-filter system, with preliminary treatment in settling basins, or "septic" tanks, and with final sedimentation for a brief period.

Upon the presentation of the completed plans, notwithstanding their approval by the state health authorities and by experts called to pass upon them, serious opposition arose, principally from three sources. The first opposition sprang from the determination of certain politicians, backed by the local paper, to commit Mount Vernon to the scheme of turning all its sewage into the Bronx Valley sewer. The impracticability of this plan was made clear, involving as it did a costly pumping plant, or a tunnel a mile or more in length, to divert the drainage to the west, against the natural slope eastward. Second, there were the representations of interested parties in favor of a system of chemical purification. It was not difficult to demonstrate the inadvisability of this retrogressive plan, as to first cost, expense of operation and character of the results. Third, many citizens, particularly east-side residents, naturally suspicious of an installation so unfamiliar and of which few, if any, examples existed in this country, were especially alarmed through fear that the bad odors from the proposed plant would become a greater nuisance than that which the court had ordered abated, and that the east-side residential district would become uninhabitable. It was pointed out that where such plants had been operated there was no offense from odors, but, in order to completely meet the objections raised, attention was called to the provisions of the plans for covering in, and roofing over, all structures, and, in addition, providing special means for deodorizing hydrogen sulphide in ventilating towers, using mechanical exhaust for forcing air from the filters and tanks through thin layers of iron oxide. All objections having at length been satisfactorily disposed of, the plans were finally approved and the work put under contract.

The Design of the Works

When the plans for the Mount Vernon disposal plant were prepared, in January, 1908, the population of the city was estimated at 28,000. This was not far from correct, the census of 1910 giving 30,900, but the estimate of sewage flow at 2,700,000 gal. a day, based on the assumption of nearly 100 gal. per capita, is probably much in excess of the normal dry-weather flow, as the city is almost entirely of a residential character, with few manufacturing establishments, its water supply (obtained from a private company) metered to consumers, and its sewers built under the separate system, street water and roof water being excluded—at least, by city ordinance. Under such conditions, the normal dry-weather flow might be safely reckoned at 70 or 75 gal. per capita. The water company claims to be pumping some 3,000,000 gal. a day, but with an estimated loss of 40%.

A general plan and a general section of the works, together with some details, are shown by Fig. 1. Some construction details not illustrated in this article were shown in an article by George L. Robinson, which appeared in Engineering News of Apr. 29, 1909, while the plant was under construction.

Low-level Pumping Station—About three-fourths of the normal flow of sewage of the city comes to the works by gravity; the remainder, which includes the flow from a low district in the eastern part of the city, comes to the works by a low-level sewer which terminates at the pumping station, between the sludge tanks and the filter beds (Fig. 1). The pump house, a concrete structure with tile roof, 25x35 ft. in ground plan, contains two electrically driven centrifugal pumps, each of 700 gal. per minute capacity, the lift being about 22 ft. A longitudinal wall divides the space beneath the floor into two pump pits, each 11x33 ft., with screens, also with ball floats for automatically starting and stopping the pumps, the range of the rise and fall being about 18 in.

Settling or Septic Tanks—The five settling basins (or "septic" tanks) form a single structure (Fig. 1) of reinforced concrete, divided by four 10-in. partition walls and provided with a 6-in. floor and a 6-in. slab roof. The roof is carried on 10x10-in. posts, 12 ft. c. to c., with 9-in. beams between the posts.

Each basin or tank is 50 ft. wide and 100 ft. long, with an average depth of about 9 ft. below the water line, each tank thus holding about 330,000 gal. One foot below water line, a network of iron rods extends rectangularly and diagonally from post to post. Near the eastern, or

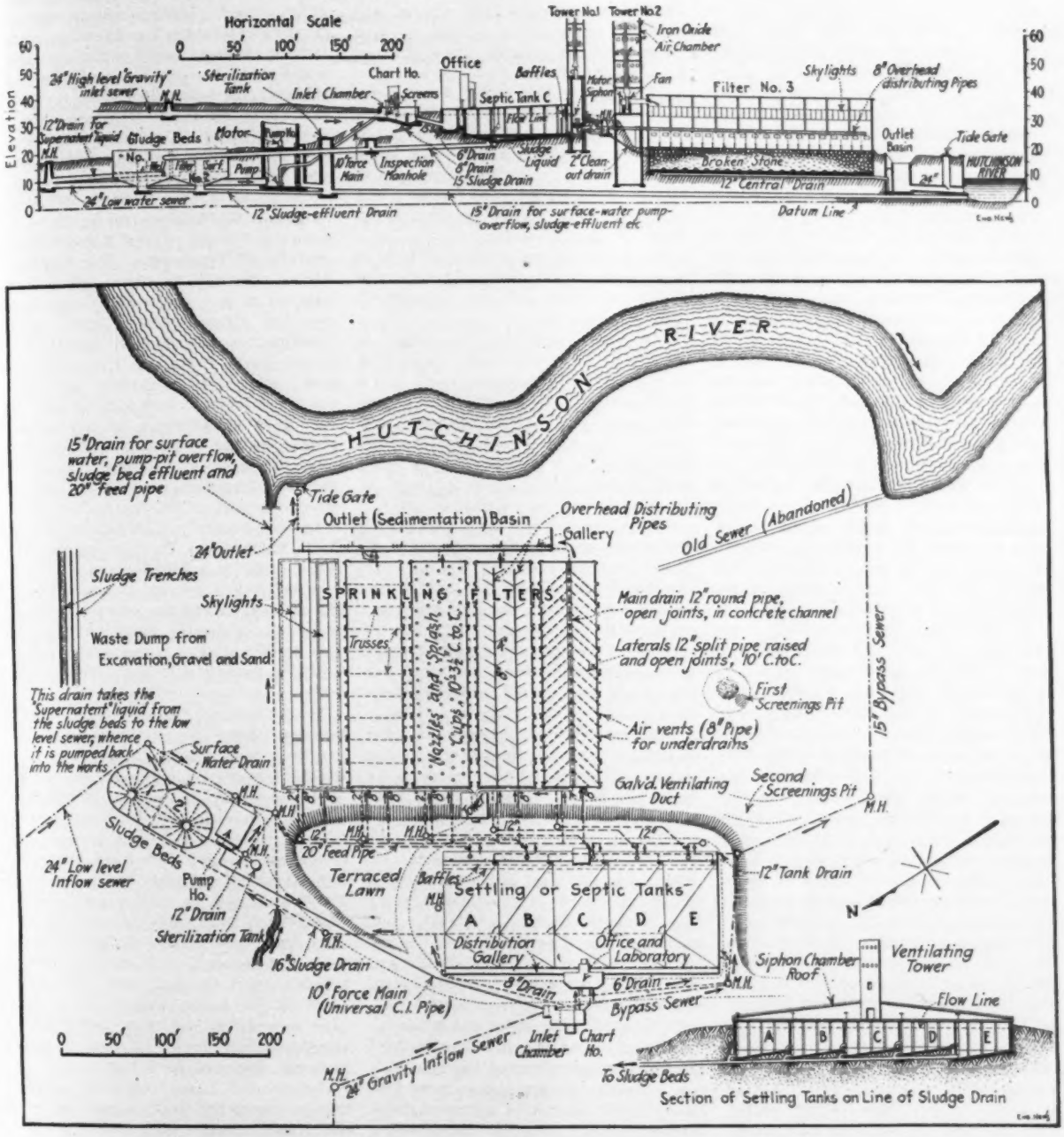


FIG. 1. GENERAL PLAN AND SECTIONS OF SEWAGE TREATMENT WORKS AT MOUNT VERNON, N. Y.

outlet, end, are two baffle walls, the first carried up to 1½ ft. below the water line, and the second (or curtain wall, supported on posts) extending from the top of the tank to about 2½ ft. below the water line and forming a scum board. Openings in the bottom of the first and top of the second wall provide for drainage and ventilation.

Across the western end of the tanks is the receiving or distribution gallery, 5x5 ft. in section and 255 ft. long, with three 12x24-in. inlet sluice gates for each tank. Across the eastern end of the tanks is the siphon-chamber (or dosing-tank) gallery, with the walls carried up to an inclined roof (lighted by glass panels). This roof slopes upward toward the smaller ventilating tower, which is equipped with exhaust fan, motor, air chambers and layers of iron oxide. The tower has five stories, with outlet openings in the outer walls, the same as in the large tower for the filter beds. (See ENGINEERING NEWS, Apr. 29, 1909, for details.)

The flow from each septic tank to its siphon chamber passes over two 10-ft. weir openings, in the center of each of which is placed a rectangular siphon for intermittently drawing down the septic liquid 6 in. The dose is delivered by five 10-in. Miller siphons—one in each dosing tank. Each siphon is connected by a separate 12-in. pipe to the filter bed it serves; also directly to the 20-in. feed pipe that extends for a length of 360 ft., in the space between the tanks and the filters. Each dosing tank has also a di-

rect (12-in.) connection with the main (20-in.) feed pipe independent of the siphons. Three 12-in. gate valves control the discharge from each siphon chamber: (1) direct to the feed pipe; (2) siphon to feed pipe; (3) siphon to filter bed. Including the 8-in. gate valves on the ten lines of distributing pipes to the filters, there are 25 gate valves in all, for regulating the flow to the five filter beds.

The settling basins ("septic" tanks) were designed to handle the sludge by gravity, the series of floors forming a vertical profile "en eschelon," each having a transverse slope of 1 in 20 to the low point in the north wall, about 30 ft. from the entrance sluices. The floor also slopes longitudinally from each end to the same point, so that, at the base of the end walls and of the south wall, the floor is at the same level, 2½ ft. above the low point. Here a 16-in. sluice gate allows the sludge liquid to be drawn off through connection with the underlying drain of 16-in. cast-iron pipe, which is continued beyond the tanks by a 15-in. vitrified-tile drain to the sludge tanks, with a uniform fall of about 1 per cent. Four feet above the bottom of each septic tank is an 8-in. flushing gate on the branch pipe to the main drain.

SLUDGE BEDS—The sludge-bed structure (Fig. 1) of reinforced concrete is built on low ground east of the filters. It is oblong in plan, has a slab roof on posts, and is divided into two equal portions, each capable of storing about 400 cu.yd. of semi-dried sludge. The concrete bottom in each tank slopes to a central wall which receives the radiating, split-pipe underdrains, and from which the effluent drain leads either to a sterilization basin or directly to the river. The filtering medium consisted of 18 in. of broken stone and cinders or sand, but was found useless in operation, the sludge sediment being too dense to allow any liquid to pass through it. A better way of taking care of the excess liquid was found, as will be mentioned later on, so that no sludge-effluent enters the stream, thus eliminating the need of sterilization.

SPRINKLING OR PERCOLATING FILTERS—In laying out the main features of the disposal works, it was assumed that the wants of the city for five or ten years to come would be met by the use of sprinkling filters, aggregating an area of 1.25 acres. The instalment consists of five units, each 50 ft. by 210.5 ft., located at the river bank, with ample space for additional units, as required. Preliminary treatment is afforded by five septic tanks on higher ground, the topography being very favorable to such an arrangement, allowing a total fall of 22 ft. from the inflow level to the river at high water.

The filter beds (Fig. 1) are separate structures, with a space of 9 ft. between each unit. They are built of concrete, reinforced at the buttresses which carry the trusses. Each bed is sheltered by a boarded jack-raftered roof, covered with asbestos roofing and carried by steel trusses and purlins, with a row of movable skylights in each pitch.

The concrete floor of the filters slopes 1 in 25 to a 12-in. central drain, into which enter, at an angle of 45°, the 12-in. split-pipe laterals, laid with open joints, 10 ft. c. to c. Each lateral passes through the filter wall and connects with an 8-in. air vent carried up about a foot above the ground surface.

The filter medium consists of 8 ft. of 3 to 1½-in. broken stone. This rests on 12-in. stone, laid with care between the lateral drains.

The whole structure, from floor to ridge, including the overhead distributing as well as the underdrain pipes, has a longitudinal slope or fall toward the river of 0.7%. Galvanized-iron boxes, 30x30 in. in cross-section, lead from the gable end of each filter to the large ventilating tower, there connecting with an exhaust fan run by an electric motor.

SPRINKLERS — The 8-in. distributing pipes (two to each filter) extend from the 20-in. main feed pipe, and are carried by the chords of the roof trusses and by wire hangers, through the length of the filter and about 6 ft. from the surface. From these two lines of pipes, 4-in. branch pipes project on each side at an angle of about 60°, and at the ends of these, as well as at the intersections, the delivering nozzles are inserted. The descending stream from each nozzle strikes a splash cup placed directly under the nozzle on an adjustable stand made of two sections of pipe, telescoping and held by set screws. The base of the stand is a broad flange resting on a concrete cylinder, 15 in. in diameter and 4 in. thick, bedded in the broken stone flush with the surface. A very good foundation was thus secured, with means for quick adjustment, both laterally and vertically. "Universal" cast-iron pipe, with bolted joints, was used for the 8-in. and 4-in. distributing pipes and fittings.

Although the plans and specifications for this plant were rushed through, with the intention of starting construction early in 1908, so that its operation could commence in the spring of the following year, yet, owing to the various setbacks and delays, some of which have been mentioned, the contract was not signed until the following October, resulting in the suspension of the work by cold weather, two months later. Advantage was taken of this interruption to redesign the distribution piping, in order to secure greater flexibility of operation.

The most notable feature in connection with the resumption of construction work in the spring of 1909 was the experimental tests, conducted by the writer (see description of the same in ENGINEERING NEWS of Mar. 24, 1910), to ascertain, by actual trial under the conditions which would obtain when the plant should be put into operation, what form or shape of splash cup or sprinkler would give the highest percentage of efficiency of distribution over the surface of the filter bed. This was especially important, as no plant had been previously built to use the overhead system, which had been developed experimentally by Profs. C.-E. A. Winslow and Earle B. Phelps at the Sewage Experiment Station of the Massachusetts Institute of Technology. The excellent results obtained by them led to the adoption of their gravity-distribution plan for the Mount Vernon work. After numerous experiments and calculations, it was found that a cup made of sheet metal, about 3 in. in diameter and 1 in. deep, and provided with a rolled edge or rim, gave an efficiency of distribution running as high as 90% or over, and this form was accordingly adopted. The spray thus produced from each nozzle stream, by the reaction of the cup surface, covered very evenly a circular area about 21 ft. in diameter. By allowing the circular areas to slightly overlap a very satisfactory and uniform distribution over the entire filter bed was secured under a practically unvarying head. A detailed plan of the sprinkler layout was given on p. 466 of ENGINEERING NEWS for Apr. 29, 1909.

FINAL SETTLING BASIN—The only other structure of the disposal works proper is the final sedimentation basin (Fig. 1), located between the filters and the river. This is about 230 ft. long and 20 ft. wide and was originally in five compartments. There is a receiving gallery in front of the basin, into which discharge the central 12-in. drains from the filter beds. The flow through the basin was originally controlled by flashboards, so that it might enter the upper (or south) end of the basin and thence flow through its entire length to the lower end, from which the final (24-in.) outlet, trapped by a tide gate, extends to the river, being submerged at half tide. (Changes in this basin are described further on.)

OFFICE AND LABORATORY—The office and laboratory building is located at the center of the distribution gallery, and opposite to it is the inlet chamber, with screens and measuring weir, which, together with a water-clock recording apparatus and chart, graphically showing the rate of inflow at any moment, was designed by the writer during construction. The sum of the hourly averages thus obtained gives the total daily flow.

OPERATION OF THE WORKS

Upon taking charge of the works in July, 1910, the writer found that considerable preliminary work had to be done and that the sewer connections had not all been made. It was not until Aug. 19, 1910, that sewage was admitted to the

works for treatment. At first, only a part of the gravity flow could be received, while the low-level sewer and pumping plant were not ready for use until a month later. Then there were a number of interruptions; from a ten-days' water famine, a break in the main sewer, repairs of leaky inlet sewer, and on one occasion the unlawful discharge of gas-tar into the sewers.

The principal features of operation, to be briefly mentioned, are the records of hourly and daily fluctuations of inflow, also as affected by storm water and ground water, progress of putrescibility tests by the methylene-blue process, methods of intermittent dosing and siphon control, action of filter beds and sprinkling apparatus, cleaning and screening operations, and the formation and disposition of sludge.

The inflow profile (Fig. 2) shows the effect of rain on the flow of sewage, both at the time of the storms and in the subsequent increase from ground water. Notwithstanding a city ordinance forbidding it, many houses have their roof-water drains connected with the sewers, and in some instances street water also enters. Furthermore, as the sewers of Mount Vernon, though planned on the separate system, are, in many cases, built by local contractors with inadequate inspection, and the work accepted without testing for tightness, ground water, as might be expected, enters freely, its amount varying with the season and the rainfall (as quite clearly shown on the chart of hourly flows). At night, when the normal flow of sewage is small, ground water leaks in, and in daytime, when the normal flow is large, sewage leaks out, so that it is difficult, in fact impossible, to determine what is the normal dry-weather flow or the actual water consumption of the city.

The Mount Vernon sewage is domestic in character, almost entirely free from trade wastes, analysis showing about 200 parts per million of suspended solids in screened sewage; oxygen consumed, 100; dissolved oxygen, 37% of saturation in screened sewage and 58% in final effluent.

Screenings average less than ½ cu.yd. per 1,000,000 gal. They are raked off about once in two hours and immediately taken in barrows to the screen pit or dump and covered at once with fresh earth.

The operation of the works has been characterized by a remarkable freedom from odors. Hydrogen sulphide in the air over the filters has been found to the extent of about one part per million, while in the septic tanks this gas is not given off, nor has ebullition been much in evidence. Scum has formed occasionally and then, after a time, has wholly disappeared, perhaps due to fluctuations of surface flow through intermittent siphon action.

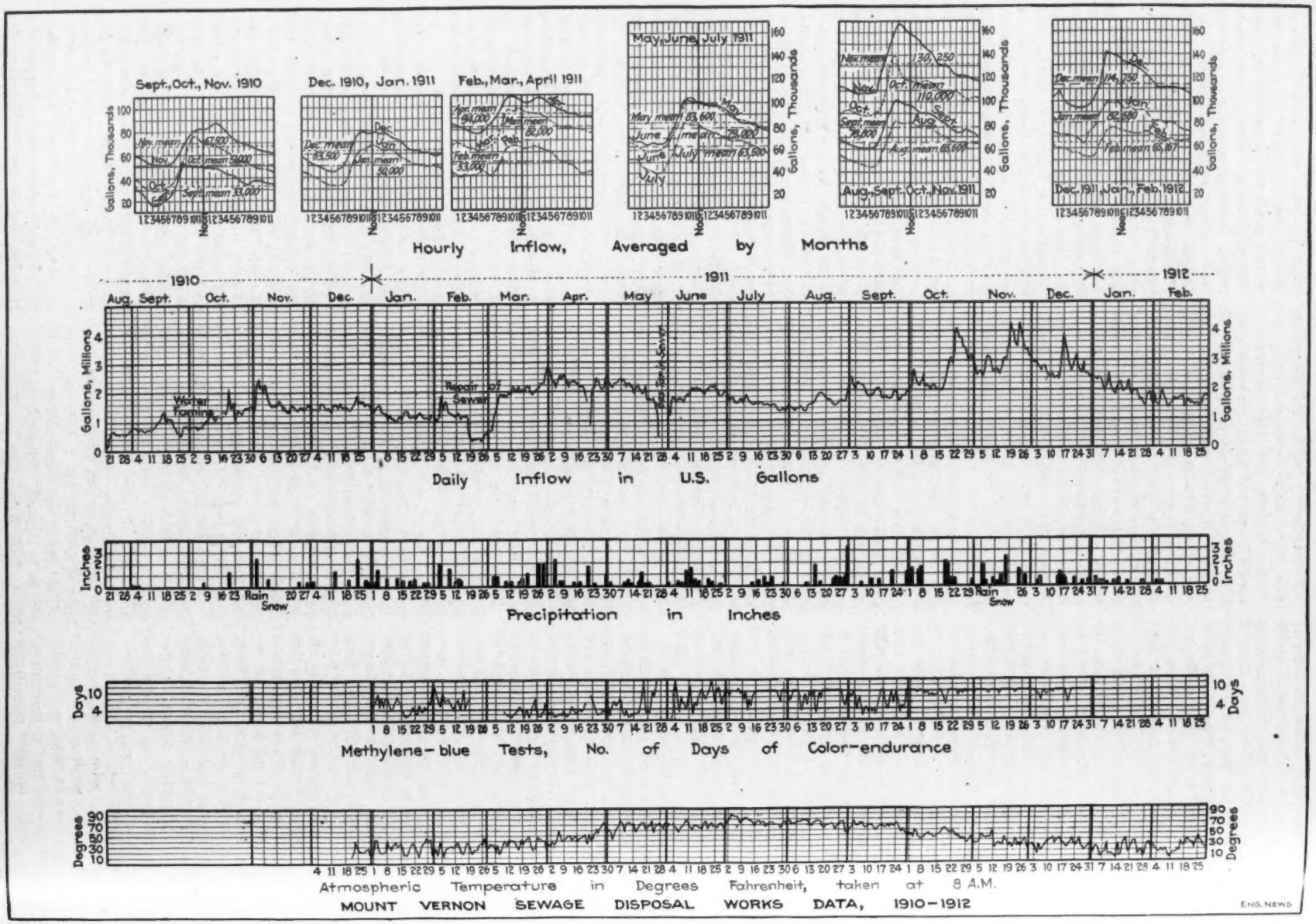
PUTRESCIBILITY TESTS—The methylene-blue tests were conducted after the Phelps formula, six daily samples of each filter effluent being combined in an 8-oz. composite sample, and a record kept of color endurance up to 10 days. The average result of all the filters, as represented by Fig. 2, showed considerable fluctuation at first, and especially after interruptions and unfavorable conditions, but at length it indicated a very satisfactory working. This method doubtless unduly accentuated the temporary variations at time of collections, but that now followed (of sampling the final effluent of the entire plant) gives a remarkable series of uniform results, the color holding for 20 days, or longer, with scarcely an exception.

GENERAL RESULTS—The filters with an area of 1¼ acres and an average flow of 2,000,000 gal. a day, at a rate of 130 gal. per cu.yd. of filtering medium, have given good service. The greatly increased flow at times of storm and from infiltration seems to have had no ill effect. Probably the gross amount of solids has not been thereby increased, except that on a few occasions of very heavy rain considerable street sand was received in the inlet chamber, thus turning it into a grit chamber back of the weir, and necessitating the removal of the sand by barrows. Overdosing of the filters is most likely to occur during the heavy spring rains. At that season some pooling is noticed, but by May, with the increase of temperature and of larvæ in the upper layers of the beds, the pooling disappears, and is not seen again until the wet season of the next year.

The spraying effected by the splash cups has been remarkably good. The best results were obtained with ½ in. nozzles delivering a solid cylindrical stream at a height of 4 ft. above the cup, which is placed 18 or 20 in. above the surface of the filter. To get the full effect, however, and secure, as was frequently demonstrated, 90 or 92% of perfect distribution, the head on the nozzle should be at least 5 ft., or about 11 ft. above the surface of the filter beds. The original high-water line, or starting level for the siphons, was 11.84 ft. above the filter surface. If the siphons are allowed to start under a low head (as, under some conditions of venting, would be the case), the distribution will be confined to smaller circles of area.

SIPHONS AND DOSING—A peculiar feature in the Mount Vernon plant is the method of drawing off, through siphon action, a depth of only 6 in. of the septic-tank liquid at each dose. The design called for siphons capable of discharging one hour's flow in 40 minutes, on the basis of 3,000,000 gal. daily inflow. The original design also required that Tank A effluent be applied exclusively to Filter No. 1, Tank B to Filter No. 2, and so on—an arrangement in series. The writer soon found that, with a daily inflow of, at first, only 1,400,000 gal., and even when it afterward averaged 2,400,000 gal., such a method of operation gave far too long a period of detention in the septic tanks, as well as of dosing on the filters. Careful study was given to the problem of reducing the detention period, increasing the frequency of the dose, and shortening the rest between doses; and, at the same time, of not being obliged to run all five tanks whenever all the filters were in operation. The method adopted may be called an arrangement in parallel. Through valve control, the 20-in. feed pipe was made the means of common communication between the five siphon chambers (afterward, this was made still more effective by making openings in the partition walls between the chambers), thus converting them into a single dosing tank. The siphon discharge to the filter beds was then regulated by opening and closing the gate valves by hand. Later, the same regulation was effected, manually, by means of air valves placed in the siphon bells. Finally, a simple method was worked out for controlling the intermittent action of the siphons by synchronizing their action, so that all should do their part and not one or two only, and the whole operation be made automatic and capable of adjustment to conditions. Means for accomplishing this result by special adjustable vent pipes were about to be installed, at a very slight expense, when a change in administration deprived the writer of his position as manager. If the main (10-in.) siphons do not all start together, one or two of them doing the most of the work, they do not succeed in overcoming the flow from the overhead (rectangular) siphons; hence, the main siphons, not getting a proper vent, continue to work, under a low head, unfavorable to securing good distribution and a regularly intermittent action of the filters.

By the original plan of working five tanks and five filters in series, the dose would consist of five times 18,650 gal. (the top 6 in. from the septic tanks), plus the capacity of all the siphon chambers (or 9350 gal.), plus the inflow during the siphon action of, say, 40 minutes. The resting time for refill (102,600 gal.) would be nearly an hour, with a 2,500,000-gal. daily inflow. Thus, besides allowing too much septic action, the filters would receive but 15 doses a day, while the new plan (started in January, 1911) of 15 minutes on and 15 minutes off, not only increased the frequency to 48 doses a day, but also made it possible to use only one or two tanks with the five filters. With the use of two septic tanks, the average velocity of flow, based on the tank cross-section, would be only 2 or 3 mm. per sec.; but the surface velocity, increasing as the discharge end is approached, must be much more than that.


Sept., Oct., Nov. 1910
Dec. 1910, Jan. 1911
Feb., Mar., April 1911
May, June, July 1911
Aug., Sept., Oct., Nov. 1911
Dec. 1911, Jan., Feb. 1912
Gallons, Thousands
Hourly Inflow, Averaged by Months
1910
1911
1912
Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb.
Gallons, Millions
Winter Flooding
Repair of Sewer
Daily Inflow in U.S. Gallons
Inches
Rain
Snow
Precipitation in Inches
Days
Methylene-blue Tests, No. of Days of Color-endurance
Degrees
Atmospheric Temperature in Degrees Fahrenheit, taken at 8 A.M.
MOUNT VERNON SEWAGE DISPOSAL WORKS DATA, 1910-1912
ENG. NEWS

The discharge from each septic tank reaches the siphon chamber through two rectangular (Miller patent) siphons of 24x4-in. cross-section. They act simply as weirs until the siphon chamber is filled high enough to seal their outlet ends, whereupon what little air there may be at the bend of the siphons is quickly drawn out by the friction of the flowing liquid, and true siphon action begins and continues until the high level is reached at which the main (10-in.) siphon starts, and until its greater capacity at length unseals the small siphons, by which time they have drawn down the level in the septic tank 6 in. The large siphon then continues alone until its venting level in the siphon chamber is reached, thus completing the dose.

In regard to the action of the Miller siphon, so great an authority as London *Engineering* stated that if the discharge leg of the siphon were simply the ordinary S-trap, it would not work. The writer's experiments with a glass model showed that such is not the fact. Its *modus operandi* is as follows: As the water rises outside of the bell, the air within the bell, and in the discharge tube above the trap, is compressed, keeping the water level inside the bell below that outside, and forcing the water in the upper leg of the trap down to the bend (the level rising correspondingly in the other leg). This action continues until the water within the bell reaches the top of the discharge tube and begins to dribble over it. The escaping water around the bend of the trap is now seen to be filled with air bubbles, which rapidly increase, the air thus lost or displaced allowing the water inside the bell to rise higher and overflow more freely into the discharge tube, carrying air bubbles with it until the whole bell is filled with solid water and siphon action is set up with a rush. When, however, the siphon has drawn the tank down to the vent level, if, then, the inflow continues to supply a certain amount, the venting will be imperfect and the siphon may continue to work indefinitely under a very low head.

Minor Cleaning Operations — The general method of cleaning the shallower basins, galleries, etc., has been by water carriage, first stirring up the bottom sediment by long-handled squeegees and then allowing the thickened liquid to drain off by the proper channels. In cleaning the distribution gallery (about twice a year) the same method was followed, but after a thorough mixing of the deposit with the inflow, the sluice gates or inlets to the septic tanks were closed and the flow-line raised a foot or more above normal. Upon again opening the gates, the diluted liquid then passed into the septic tanks with the usual flow. A thorough cleaning could thus be accomplished, as often as needed, without shutting down the plant in order to remove the deposit by shovels.

Sludge and Sludge Disposal—The final sedimentation basin was built in five compartments, the flow passing from one to another over weirs. The basin was made self-cleansing by removing the division walls, as the deposit consisted merely of mineral matter—chiefly the washing out of stone dust, mica, etc., from the filter beds—small in amount, considered as a percentage, but of considerable trouble to handle. The crushed stone for the filters, obtained by completing a nearby rock-cut of a railroad's abandoned location, was generally of a hard and satisfactory quality. Though carefully screened, subsequent handling and dumping created some dust.

In designing the "septic" or settling tanks, four things were kept in mind: To make the length and breadth dimensions moderate, in proportion to the depth; to give the bottom a decided slope from all points to a single outlet; to provide ample means for a complete drainage of the sludge liquid; to keep back the scum from the siphon chamber, and lessen, if possible the formation of scum mat. Each tank is 50 ft. wide. The run of the flow is 91 ft. to the first baffle wall, in the bottom of which are wide openings for drainage. Four feet beyond is the upper baffle, and 4 ft. further on are the rectangular siphons discharging into the siphon chamber. By placing the low point (at the north wall) about 30 ft. from the west (entrance) end and 2½ ft. below the floor level at the end and south-side walls, the three floor planes thus formed have a slope of 1 in 12 from the west (inlet) end; 1 in 24 from the east (outlet) end; and 1 in 20, transversely, from the south side. As a result of this construction, the depth below the water line at the lowest point being 10½ ft., the sludge liquid is kept in a deep pool in the vicinity of the outlet drain, and, in the tank which had been the longest in continuous operation, the depth of this sludge never exceeded 3 ft. at the low point of the tank. The 16-in. sludge drain, passing under the tank floors, with branch connections at each low point, laid on a 1% grade, produced a rapid flow of the sludge liquid, without the need of using the high-level flushing pipes; and a cylindrical inspection manhole, 5 ft. in diameter and 3 ft. deep, with movable wooden cover, provided means for examining the character of the liquid as drawn off.

Although hydrogen-sulphide was never given off in any appreciable amount at the surface of the "septic" tanks it was abundantly present in the sludge liquid itself, but after reaching the sludge tanks it rapidly lost the odor as the liquid solidified. This coagulation, if it may be so called, took place very soon after the liquid entered the sludge tanks, which, as before mentioned, were provided with filtering material (which did not filter) and underdrains for carrying off the effluent for sterilization, if desired. But a better way was found. The movable plank bulkheads, for access to clean out the sludge tanks, allowed the excess liquid to leak out. The writer, soon after taking charge, built a sump in front of the bulkheads, and laid a drain from thence to the nearest manhole in the low-level sewer. By this means the excess liquid, mingling with the sewage inflow, was pumped back into the works, with no further trouble.

The residue in the sludge tanks was allowed to remain for five or six months, when it became completely dried out, non-odorous, appearing like rich garden mould. Weeds often grew on it, and in one instance a number of tomato plants sprang up and bore quantities of excellent fruit. This dried sludge was easily handled by spades and wheeled out in barrows to a trench about 4 ft. wide and 2 or 3 ft. deep, dug in the gravel of an extensive waste dump, left during construction. Each barrow load was covered in at once. In this waste area of about one acre there is room enough for such a system of parallel trenches to last for a long period of years, about 600 sq.ft., only, having thus been utilized, so far. Each of the two sludge tanks will hold about 400 cu.yd., equivalent to 80,000 gal., or more than the sludge pool, as permitted by the writer's management, in either of the septic tanks. With two of the latter in service, each cleaned of sludge not oftener than once a year, it is thus seen that there is ample provision for six months' drying of sludge and its disposal with no other inconvenience than its removal into trenches. After filling one of the sludge tanks about 4 ft. deep, the excess liquid draining to the sewer, as above stated, the residue continues to shrink to only about a third of its original volume, when it is ready for trenching, or for sale as a fertilizer of some value.

Experience in the operation of this plant indicates that the amount of sludge formed depends, to a considerable extent, upon management and upon watchfulness of changing conditions. The method which seemed to give the best results was to reduce the period of detention in the settling tanks to 6 or 8 hours, keeping them well supplied with fresh sewage, with a regularly intermittent lowering and raising of the water line (6 in.) and consequent varying of surface velocity. Under such conditions, sludge digestion proceeded rapidly enough to prevent undue accumulation of sediment. It was noticed that if the tanks discharged into the siphon chamber continuously, and so gradually, by a simple weir flow, instead of the rapid oscillation of siphon action, scum began to form quickly on the discharge side of the baffles. In short, the tanks seemed extremely sensitive to any variation of regimen. For example, three tanks (Nos. 1, 3 and 5) were found to be at least one

too many for a midsummer flow, during a very dry period, and a slight difference of gate-level diverted the flow away from tank No. 5, which also had a slightly higher discharge level, causing a rather stagnant condition in that tank. In two or three weeks, heavy and dense sludge and scum formed in tank No. 5, while the other two were entirely free from scum, with no increase in sludge liquid. The tank was put out of commission and cleaned, the other two continuing their work with no change of conditions.

Frequent examinations of the sludge liquid at the bottom of the tanks were made by means of a "thief"; a wide-mouthed bottle fastened to the end of a long pole, and closed by a leaden conical stopper attached to a wire leading to the top of the pole. On depressing the pole to the bottom of the tank at its lowest point, the stopper is lifted, the bottle filled, the stopper dropped, and the pole drawn up with the sample. Another bottle is lowered in the same manner to a given height above the bottom, and drawn up as before. In this way, the condition of the tank at different depths was ascertained and recorded. The sludge samples, especially the bottom bottles, showed in 12 hours the characteristic separation into top and bottom masses with water between, similar in appearance to that which has been described of the samples taken from Imhoff tanks.

The total amount of sludge removed from the settling tanks during the first 18 months' of operation was a little less than 500 cu.yd. in a total inflow of 960,000,000 gal., or about ½ yd. per 1,000,000 gal. Of this amount of sludge, about one-half had been dried out and buried in trenches, and the remainder, in sludge tank No. 2, would have been removed in April last, had the writer continued in charge, leaving both sludge tanks empty and ready for the accumulation of another 18 months, perhaps three years, of operation.

COSTS OF CONSTRUCTION AND OPERATION—The cost of this plant, including the pumping station for the low-level district, will be not far from $150,000, when the claims for extras (not yet adjusted) are paid. Of this amount, at least one-third, or $50,000, represents the added cost of covering the filter beds and other structures and the building of the two ventilating towers, including motors, exhaust fans and about 11,000 bu. of "iron oxide"—not filings but fine shavings thickly coated with iron rust.

The cost of operation has necessarily been much influenced by the restrictions of state law and municipal ordinance, fixing eight hours as a day's work for city laborers and their compensation at $2.50 per day. However, apart from the pumping-station maintenance and attendance, the cost of running the disposal plant proper, under the limitations mentioned, figured out about $7 per million gallons.

The covering of the filter beds has some advantages, especially for the overhead system employed, or for any other system, for that matter, in the protection obtained from wind and snow, and perhaps in lengthening the period of seasonal warmth, the temperature within the filter houses even in severest weather, never getting below 34° F.

VENTILATING AND DEODORIZING TOWERS—In regard to the ventilating towers and apparatus for gas deodorization, it was the writer's judgment, and his suggestion during construction, that they were likely to be of so little practical benefit that they might well be omitted, at least until the operation of the plant had indicated otherwise. The suggestion was not adopted, however. Although, upon trial, the electrically driven fans proved capable of efficiently changing the air as designed, they were never used (except for test) during the operation of the plant, but, instead, a large central pipe was carried up to the top story in each tower, and the natural draft thus created answered every purpose.

To conclude: The plant has proved to be in a remarkable degree non-odorous, producing a very stable and non-putrescible effluent, discharging into an estuary, of which the tidal prism must be much more than a million cubic feet, thus affording abundant dilution. Its successful operation, the writer believes, is largely due to the change made by him in January, 1911, from series to parallel method of working, combined with greater frequency of intermittent dosing and a more perfect control of sludge formation. The plant has been visited by many engineers and others interested in sanitary progress, who have been pleased to express their commendations. The writer particularly desires to acknowledge the very helpful suggestions received from Professors Winslow and Phelps, both at the time the plans were in preparation and during his subsequent management of the works.

Covering Worn Timber Piles with Cement-Gun Concrete

Timber piles in marine work in northern Pacific waters are very apt to be attacked by the so called sand-flea and rapidly eaten away. In a timber wharf for the Seattle Electric Railway Co., at Seattle, Wash., these attacks became so great as seriously to endanger the safety of the structure (Fig. 1) and covering the piles by concrete thrown on from the cement gun was resorted to with considerable success. Figs. 2 and 3 herewith illustrate the process and the final appearance of the coated piles.

FIG. 1. TIMBER PILES ATTACKED BY SAND-FLEA

FIG. 2. FIRST STEP IN PROTECTION

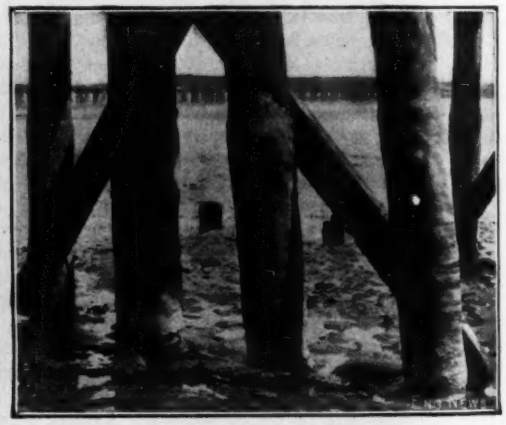


FIG. 3. PILES COVERED WITH CONCRETE

Ordinary poultry wire was stretched around the piles and a cement-gun mixture driven against the reinforcement from the nozzle of a cement gun, to a thickness of from 1½ to 2 in. The work was done between tides and the mortar received its set before the water reached it. About 500 piles were coated in this manner at a cost of about $4 per pile.

Concrete Timbering for Mine Shafts*

By E. R. Jones†

The use of shaft lining composed of reinforced concrete posts and sills instead of the usual timber sets employed for the lining of mine shafts is a novel development in mining and in concrete work. This article describes the concrete sets, and also their manufacture and use, in two copper mines.

Monolithic concrete, plain and reinforced, has been used for a number of years for shaft collars and shaft lining at mines where conditions warranted such permanent construction, but not until 1909 was reinforced concrete tried in the form of separate members handled and placed in the same way as the ordinary timber sets for shaft lining. This first experiment was at shafts No. 3 and No. 4 of the copper mine of the Ahmeek Mining Co., at Ahmeek, Mich.*

Two distinct kinds of concrete were used in the beginning: (1) a good grade of gravel and natural sand from a local pit; and (2) the trap rock through which the shafts were being sunk, together with clean conglomerate sand from the Calumet & Hecla mill. Sets were made from these two classes of concrete and service has proved both to be equal to the requirements. Pieces set aside for the purpose were allowed to season sufficiently that they might be given a fair competitive test. It was found on comparing the fractures that the sand and cement filling the spaces between the rounded pebbles broke away from these, while the fracture in the trap and conglomerate-sand combination continued through the larger elements of the mixture. The gravel mixture could doubtless have been improved considerably by careful washing, but the cost of preparation, compared with that of the trap-rock and conglomerate-sand prohibited its use in this particular case.

The concrete as finally used was composed of portland cement, conglomerate sand and trap rock trommeled over ¼-in. through 1½-in. screens. The proportions used were 1:3:5 in wall plates, end plates and dividings, and 1:2:4 in the studdles (or struts). The reinforcement in wall and end plates consisted of three ¾-in. monolith-steel bars with ¼-in. webs crimped onto them, together with two straight ¾-in. bars. The dividings were reinforced by four ½-in. bars wound with ¼-in. steel wire, the whole presenting a column with square cross-section. Studdles were reinforced with two pieces of old 1¼-in. wire rope. Offsets were molded in all plates 5 in. from the inside face to accommodate lining slabs. Also, holes were cored for the use of hanging bolts and bracket bolts. The wall plates, end plates and studdles have a cross-section of 80 sq.in.; dividings, 81 sq.in. The percentage of reinforcement was approximately as follows: 5% in the wall and end plates and dividends, and 3% in the studdles.

Reinforced-concrete slabs were molded for the shaft lining, the material used being fines of trap rock (under ¾ in.), and conglomerate sand, with Kahn expanded metal as reinforcement. The mixture used for slabs was 1:2:4. By way of experiment, the writer selected a piece of No. 1 hemlock plank of the same length, width and thickness as a concrete slab which had seasoned for a year; these were supported at either end, and placed side by side, and then submitted to an equal pressure applied across the center of each. Three failure cracks appeared in the concrete slab just previous

*The text is an abstract of a paper read at the Michigan College of Mines Club, at Houghton, Mich. The illustrations were prepared especially for Engineering News.

†Mohawk, Mich.

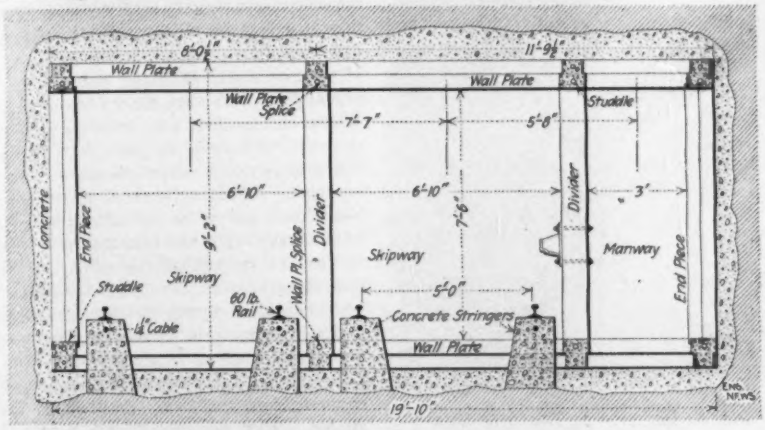


FIG. 1. MINE SHAFT (INCLINED) WITH CONCRETE SETS OF TIMBERING AND CONCRETE TRACK STRINGERS

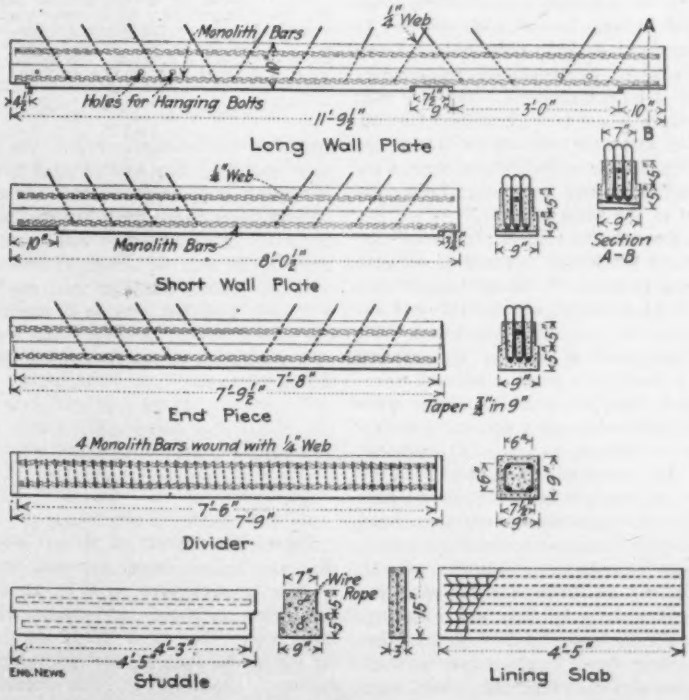


FIG. 2. REINFORCED-CONCRETE SETS OR TIMBERS FOR SHAFT LINING

*Monolithic concrete lining for mine shafts has been described in Engineering News as follows: Sept. 24, 1908; April 8, 1909; Oct. 26, 1911. The use of steel lining or "timbering" was described in our issue of Feb. 24, 1910.—Ed.

to the breaking of the hemlock plank, although total collapse of the concrete slab did not occur until the pressure was considerably increased. While the method of the test employed was crude, it proved to the satisfaction of the writer that the concrete slab was much superior in strength. Considering the rapid decay of timber used as shaft lining, no further comparison of the two is necessary.

In the molding of the concrete sets, 2-in. No. 1 white pine was used in the construction of the forms. These were soaked in Delaney's wood preservative and repainted with preservative on the interior each time before setting up. This insured them against warping, and prolonged their lives indefinitely; it also secured a smooth and easy parting from the concrete when removed. A concrete mixer of the drum type was employed in preparing the charge for the forms. The amount of water used in the mix was such that when the batch was piled, it settled rapidly without agitation. A drier mix was attempted by way of experiment, but owing to the amount of reinforcement employed, it was found impossible to ram this concrete into place.

The labor force required was six men, as follows: Two carpenters, setting up forms and keeping them in repair; one man wheeling forms onto skidways ready for filling, returning used forms to shop and cleaning the forms; one man feeding mixer from stock piles of rock, sand and cement; one man delivering mix to forms and shoveling material into place; and one mason ramming charge into final position. With this combination of men as many as four complete sets, consisting of 64 separate pieces, have been molded in one day of nine hours. In ordinary weather, the sides of the forms were allowed to remain in position over night, and then removed, while the bottoms were left in place another 24 hours. The bottoms were removed by turning the pieces on their sides, where they were left to harden one day longer before removal to the stock pile.

All through the process of removal, the sets were handled with the greatest care in order to preserve the appearance and to prevent cracking, which might not develop to the eye until weathered. All skidways used in making and storing were brought to a level to prevent warping and bending while the sets were green, so as to insure a perfect fit underground. This is particularly necessary since the concrete set (unlike timber) cannot be brought to place unless perfectly true. Sets should not have been used under 60 days after removing forms, although (through the reduction of the stock piles) we have been forced to install pieces only 14 days old. But the greatest care was observed in handling and putting these in place underground. Concrete sets one year old, which have been subjected to all manner of weather, can be abused somewhat and handled almost as carelessly as timber.

The shafts lined in this way are of the three-compartment type (with two skipways and one manway), dipping at an angle of 80°. The compartments are 7 ft. 6 in. high inside, with a width of 6 ft. 10 in. for the skipways and 3 ft. for the manways, with the end plates and dividings making the greatest span 7 ft. 6 in.

Because of the great weight of the wall plates, it was found advisable to mold them in two sections, one section spanning the ladder way and one skipway, and the other section spanning the remaining skip compartment. These two sections were connected when in place by two bolts passing through holes cored for the purpose and two straps of iron spanning the splice. Studdles were made for 4-ft., 5-ft. and 6-ft. sets, to accommodate the ground passed through. The weights of the different pieces comprising the set are as follows:

FIG. 3. INTERIOR OF INCLINED SHAFT LINED WITH CONCRETE SETS

(The posts or dividers are between the two skipways, with the back-rail attached to iron brackets on the posts. At the bottom is one of the track rails on a concrete stringer. The plank wall at the back separates the skipway compartments from the man-way compartment).

	Lb.
Long section of wall plate	1035
Short section of wall plate	700
End plate	600
Dividers	645
39-in. studdles	268
Complete set, 16 pieces	8104

Taking the weight of No. 1 Western fir, which has been exposed to the weather in stock piles, as 33 lb. per cu.ft., the above concrete set weighs almost three times that of a 12x12-in. timber set which the concrete set is intended to replace. Because of this additional weight of the concrete set, it was found necessary to increase the erecting gang from the usual 5 or 6 men on the timber sets to 7 men for the concrete sets. In a vertical shaft to which the concrete sets are especially adapted, the number of men per gang might be reduced. The sets are hung or built as the ordinary timber sets, only requiring an additional rope and block to swing the pieces in place. After the sets are wedged to line, bottoms are put in between the plates and the surrounding shaft wall, and the set is then tied to the shaft wall by means of concrete filling in the proportion of 1:3:5. The concrete slabs are then put in place, and loose rock thrown behind them, filling up what space still remains between the set and the wall of the shaft.

After the set is in place, it is extremely important that it be well protected from the blasts, for (unlike the timber set) the concrete will not stand the blast. For this purpose, the writer used flat timbers and steel plates chained to the under side of the plates and dividings, and even this precaution was at times inadequate. When the ground was breaking easily, the sets have been as near as 12 ft. to the miners; and when the ground was especially refractory, sets 40 ft. from the blast have had to be cut out on account of damage. It is obvious that it is well to keep as far behind the mining as the ground will permit. In dangerous ground, which required timbering close up to the sinking, timber sets were used; but (had not time played an important part in the sinking) no ground was met in which concrete sets could not have been installed. With a gang of seven men, one complete set can be installed in a nine-hour shift. This permits a sinking rate of better than 100 ft. per month, which was accomplished at the No. 3 and 4 shafts.

The comparative cost of the concrete set and timber set, delivered at the shaft collar is striking. The concrete set was delivered for $22.50, the timber set for $37.50. These figures are based on the following prices:

Western fir, $28.00.....per M., f.o.b. car
Crushed rock, .35.....per yd., f.o.b. shaft
Conglomerate sand .60..per yd., f.o.b. shaft
Portland cement 1.15..per bbl., f.o.b. works
Reinforcement 12.00..per set, f.o.b. factory

The Ahmeek Mining Co. was the first to adopt concrete stringers for its inclined shafts,* and the Mohawk Mining Co. soon followed with their use. At the Ahmeek mine these stringers have been in continuous use since the beginning of operations and have required no repairs. I am informed by S. R. Smith, Superintendent of the Mohawk Mine that soon after the stringers were installed, the skip repairs increased several hundred per cent. The stringers being entirely rigid and the skip also of rigid construction, the axles of the skips were found to be crystallized and the rivets

*Engineering News, Jan. 25, 1906.

working loose. This feature was overcome by molding 2-in. pine strips (treated with Delaney's wood preservative to prevent decay) into the stringers at intervals of 3 ft. These were allowed to project ½ in. above the face of the stringers, and the rails rested upon them. The pine strips have been in place four years, and none have been replaced to date, while the skip repairs have been reduced to normal. At the Ahmeek Mine the repairs were not abnormally high, possibly because of a differently constructed skip. But the same racking of the skip body occurred and the Ahmeek Co. has adopted the use of pine strips and expects to profit accordingly.

Concrete plats have been in use at both the Ahmeek and the Mohawk mines for some time. They differ from the timber plat in outward design only in the cross-section of the members; these are 9x12 in., reinforced with old rail and wire rope, and replace the 12x12-in. and 12x14-in. timbers formerly used. Holes are cored to accommodate gates for skip and dump doors and tram rails are imbedded in the concrete, making the use of spikes unnecessary. When turntables are used on the back of the plat, the rigidness furnished by the concrete insures the trammers against derailed cars resulting from a tilted table.

At the present time, the company is installing reinforced-concrete dividings to replace the practice of putting in 10-in. flat timber. In cross-section they are 9x12 in., and are reinforced by old rails. On the ladder road, they are placed 6 ft. centers and between the skip compartments they are put in as often as the hanging requires. Since the casing along the ladder road performs no other office than the protection of the men while on the ladder, or in case of a fall, plank is used for the purpose, and a 3-in. hemlock strip is molded into the dividings to facilitate the fasteneing of this casing.

Quite often in the placing of concrete and reinforced concrete, both above and below ground, not enough attention is paid to the character of the men employed in charge of the mixing and actual distribution of the material. It is not enough that the work shall look finished and neat on the removal of the mold boards; any gang of men can accomplish this, when having only this end in view. The placing of concrete where strength is desired, as well as weight and finish, requires the greatest care and judgment. Men should be selected who will see that the fines are uniformly distributed with the coarser material, for, unless the rock of the mixture is made to well overlap, segregation of coarse material and fines will occur. This will result in a weakness which often cannot be detected after the work is completed. The ideal method of placing the mix is by hand with shovel. But in shaft work, this method is slow and requires extra labor, where the work is situated some distance from the place of mixing. Where chutes are used to convey the mix to its destination, the larger material arrives in advance of the fines, making an even distribution difficult and at times impossible. The writer has eliminated this feature by placing traps at regular intervals in the conducting launders or chutes, for the purpose of retarding the larger particles, thus securing a more even mix at the end of the launders than at the beginning.

Since the cost of material for the making of concrete varies widely with the locality and the property, and there is also a discrepancy in the wage scales of the different mining companies, any detail of costs would not only prove tiresome but would be of little value, except where conditions were exactly similar to those described. Where cost is mentioned above, therefore, it is for the purpose of comparison in a special case with timber which the concrete has supplanted.

Concrete has long been used underground for bulkheads, forks, open gutters and casings for fire doors, and cannot be surpassed for these purposes. As applied to shafts, the material is comparatively new, but each succeeding year marks its advance, and in the end, timber will have been entirely superseded. For much of the underground construction, timber is still the rival of concrete; but owing to the increasing scarcity of timber suitable for mine use, it must make way for concrete and steel.

Electrolytic Action on Unreinforced Concrete*

By Cyril de Wyrall†

The effect of electrolytic action on steel and iron is generally well known among engineers, but its effect on concrete is probably not so generally understood, nor has the attention been given this subject which it should have. About five years ago the writer noticed the effect of electrolysis on column bolts embedded in concrete piers. It was evident that the concrete surrounding the bolts had become disintegrated, so much so in some cases as to render it almost useless. The effect was greatly intensified where the piers were wet. As the number of bolts in these piers was very few, the writer became interested in knowing what would happen to plain concrete if it were wet and had an electric current passing through it which could escape into the earth.

Four years ago an inspection was made of a concrete wall which was erected in 1902. This wall, which carried no load, is below tide level, is 3 ft. thick, and is made of 1:2:4 mixture of cement, sand and trap rock. It was placed with care and under competent superintendence. The examination showed a disintegration to such an extent that the surface was practically mush. A year later another examination was made, and large sections, from 4 to 6 in. thick, which crumbled in the hands, could be pulled off the face. Last year still further deterioration was found to be in progress, and a chisel could be driven 12 in. into the wall by hand alone. A voltmeter test showed that current under 11 volts pressure was passing through this structure. It was believed at the time of the second examination that the "failure" was due to the action of salt water alone, and no test was made for stray electrical currents until lately.

This is not an isolated case. There is an exact duplicate in almost every particular, except that the latter structure was erected a year later and different brands of cement were used. In the summer of 1911 the writer made an inspection of some concrete tunnels and bridges erected by three different railroads entering New York. This work has been only recently finished. Each of the railroads had its own cement laboratory, and the different brands of cement used were rigidly tested. The structures are all above tide level, and wet only in spots. Where the concrete is wet, from one to five volts was found, and the concrete is deteriorating, though not as much as in the former instances. Where the concrete is dry no voltage was found and the concrete is in excellent shape; this occurs in the same tunnel, the concrete apparently being the same mixture and placed at the same time. It seems to make no difference whether the concrete was placed in cold or warm weather, deterioration goes on just the same, the only difference being between the wet and dry places.

It is a known fact that, although wet concrete is an excellent conductor, dry concrete is practically a nonconductor. The combination of electric current and water seems to act as a disintegrating agent on the cement, destroying its cohesion and reducing it to a paste, which when dried can be pulverized with the fingers. This condition demands immediate remedial measures, or serious trouble will undoubtedly ensue.

It is only the effects which careful and continuous examination have shown, which are brought to your attention. One efficient means of preventing the damage may be mentioned, however: waterproofing thoroughly all parts of a concrete structure that is surrounded by earth. Such protection acts in two ways; it keeps the structure dry and it insulates against electric currents.

*Paper published in the Proceedings of the International Association for Testing Materials.

†Chief Inspector, Interborough Rapid Transit Co., New York City.

Double-Deck Street Cars in New York City and Pittsburgh

THE NEW YORK CAR—In ENGINEERING NEWS, Apr. 11, 1912, was shown the low-floor center-door type of car developed by Frank Hedley and J. S. Doyle, of the New York Rys. Co. The fundamental features of that design, which is giving satisfaction in actual service, are seen in a double-deck car, which has recently been placed in trial operation.

This latest car is shown in Figs. 1 and 2. By a novel arrangement of the lower-compartment ceiling and the upper-compartment seats, as shown, sufficient clearances are secured without undue height —this being only 18⅝ in. more than the standard car of the company. There are stairways at each end, back of the motorman's cabs. The total car weight, equipped, is 46,000 lb., which gives 522 lb. per seat and 266 lb. per passenger capacity including "strap-hangers."

The cabs have been lengthened 18 in. over the single-deck type, previously described; the width has been reduced also so as to give a sharper plan, which completely eliminates overhang of the ends when rounding curves.

The car is operated like the single-deck center-door type—the conductor being elevated and having a change desk for prepayment collection. There is also an annunciator by which the conductor warns passengers aloft of the street being approached; this has been installed to expedite the exit of passengers. Smoking is permitted on the upper deck and the windows and panels here may be removed for summer service. Storm curtains are used for protection in inclement weather. For winter service, both compartments will be ventilated, the exhaust fans removing the air of the upper compartment and fresh air entering the lower compartment after passing over electric heaters. The varying passenger load automatically varies the fields of the fan motors to adjust the ventilation to the needs. A thermostat controls the energy input of the heating coils.

The varying load also changes the retardation power of the air-brake equipment to give a maximum safe value at all times.

This design has been patented by Messrs. Hedley & Doyle. The car shown was built by the J. G. Brill Co., of Philadelphia.

The New York Rys. Co. has applied to the Public Service Commission for permission to issue $2,600,000 of bonds —$1,600,000 of which is intended for 320 stepless cars.

THE PITTSBURGH CAR—A low-floor double-deck car has also been brought out by P. N. Jones, General Superintendent of the Pittsburgh Railways Co. The present experimental unit has been used only as a trailer. This car was built, in the shops of the company, out of two short open cars with the platforms removed. The two bodies are joined by a 13-ft. center well framed with steel drop sills, the well floor being 17 in. above the rail and the main floors 30 in. The rest of the old construction has been reinforced with channels to support the load of the upper deck. The trucks are pivoted nearly under the center of gravity of the half body to minimize the stresses in the center drop sills.

There are two doors near the center of the car—one for entrance and the other for exit. In fact, the car has been designed to separate the streams of entering and leaving passengers as far as possible. There are two stairways to the upper deck, one for ascending and one for descending. The latter is so arranged that the exit path is very direct, the only extra travel required of a passenger leaving any point on the upper deck being the six feet of actual descent. To facilitate quick unloading, and in order to induce people to be on their feet before their destination is reached, the control of the passenger signal to the motorman is placed at the head of the stairs. The two doors on each side have been separated as much as possible to prevent awaiting crowds from interfering

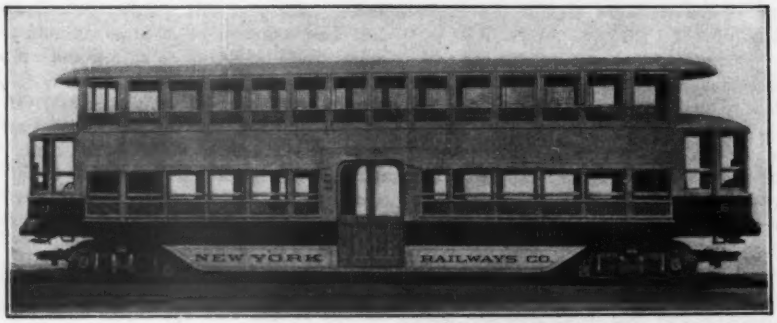


FIG. 1. THE NEW YORK RAILWAYS CO. DOUBLE-DECK STREET CAR
(Designed by Frank Hedley and J. S. Doyle; built by the J. G. Brill Co., Philadelphia.)

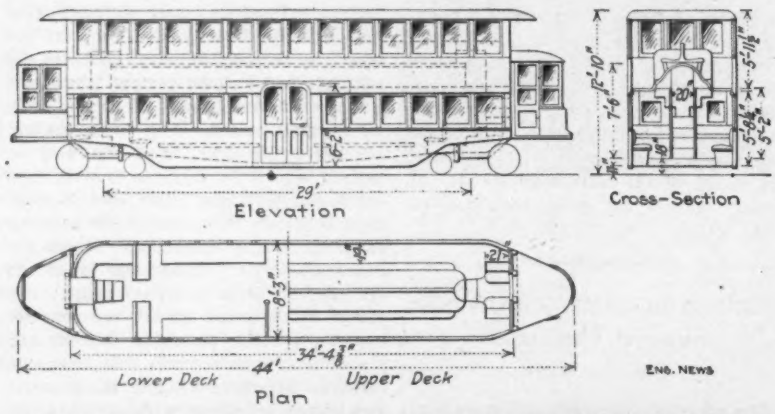


FIG. 2. PLAN, ELEVATION AND SECTION OF THE NEW YORK DOUBLE-DECK CAR

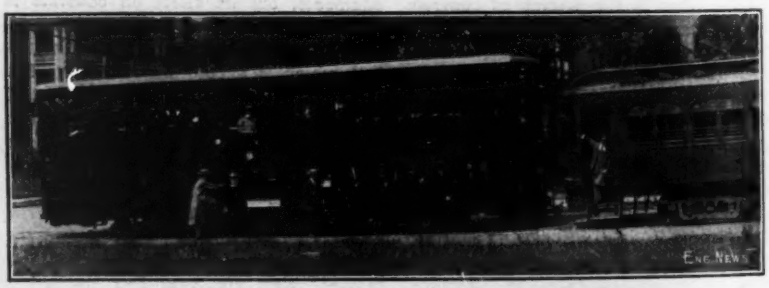


FIG. 3. THE DOUBLE-DECK TRAILER CAR OF THE PITTSBURGH RAILWAYS CO.
(Designed by P. N. Jones and built in the shops of the railway company)

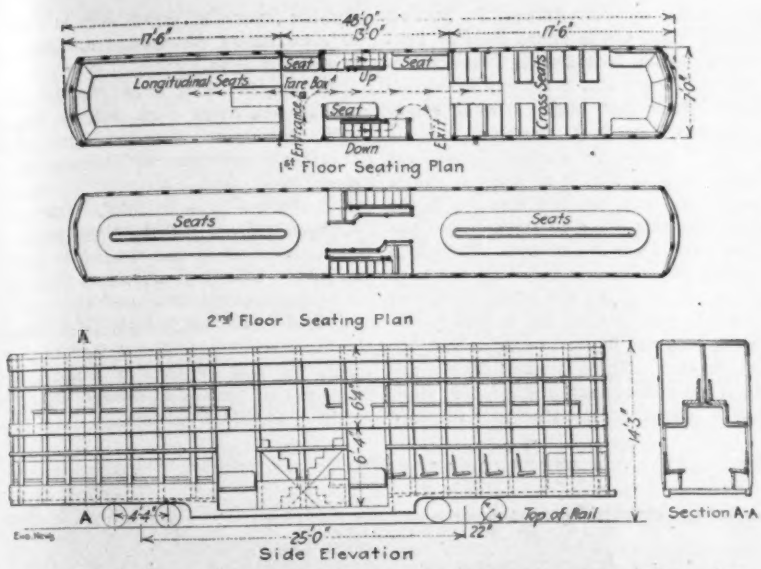


FIG. 4. PLAN, ELEVATION AND SECTION OF THE PITTSBURGH DOUBLE-DECK CAR

with alighting passengers. One-half of the lower deck has longitudinal seats while the other half has cross seats except at the end. Only removable seats are placed in the well on account of the need for double-end operation. The upper deck has only longitudinal seats placed back to back. The capacity of the upper-deck seats is 52, and of the lower-deck seats 60, giving 375 lb. estimated weight of car per seat capacity. The maximum capacity is placed at 208, which gives a unit weight of 202 lb. per passenger. This being a trail car no provision has been made for the motorman's cab.

This car was developed for special service in handling crowds such as congregate at points where large factories discharge employees who would board it at one point and leave within a restricted area. Actual experience with the car, however, shows hope of adapting the design for regular schedules with single-deck units.

Letters to the Editor

Effect of Water Cooling on the Capacity of a Blast Furnace

Sir—In ENGINEERING NEWS, issue of Aug. 22, page 339, it is stated that the increase in the output of a reconstructed blast furnace, at the plant of the Detroit Iron & Steel Co., with a new lining (13-ft. hearth), water-cooled, over that with the old lining (12-ft. hearth), is 24%.

A large part of this increase can be explained by the increase in furnace diameter. Also the output for seven months, with good business conditions and a new water-cooled lining, is compared with the average output over a seven-year period, which included some time when business was not good and some time when the lining was bad.

Therefore, I would like to ask if you can obtain information, comparing the first seven months' output of the present lining with the first seven months' output of the next preceding lining?

Also it would be interesting to know the amount and the temperature of the blast, under both conditions.

W. C. CORYELL.

Youngstown, Ohio, Sept. 8, 1912.

Another Flood in the Wisconsin River*

Sir—The Wisconsin River is on its third rampage for the year 1912, and the fourth during the past twelve months. On Aug. 31, rain began falling at about 3 p.m. Three heavy showers fell during the remainder of the afternoon, and rain fell nearly continuously all night. A total of 2½ in. fell in twelve hours. A total rainfall of 7¼ in. showed for the month of August in this vicinity. The normal gage reading at the McEachron Milling Co. mill, in Wausau, is between 4 and 5 ft. On Sunday morning, Sept. 1, at 5 a.m., the gage reading was 8.9 ft.; at 10:30 p.m. it was 12.6 ft.; Monday, Sept. 2, 6:30 a.m., 12 ft.; and at 5:30 p.m., 11.3 ft.; Tuesday, Sept. 3, 7 a.m., 10.7 ft. The highest gage reading of the flood of July 24 was 15.3 ft.

The water service of this city was cut off at 7 p.m., Sunday, Sept. 1, and remained out of commission for practically five hours. A steam engine belonging to the fire department was pressed into service and began pumping the water from the basement of the boiler room, and succeeded at the end of five hours in lowering the head of water in the basement to such an extent that the furnace fires could again be lighted. The engine was maintained in position at the plant until the water receded materially, which was Tuesday morning.

During the storm of Aug. 31 and Sept. 1, much damage was done by lightning.

FIG. 1. PIERS OF STONE MASONRY STANDING IN DAM WASHED OUT BY FLOOD AT WAUSAU, WIS.

Five barns near the city were wholly or partially destroyed by fires caused by lightning, and damage done to the extent of probably $15,000. All train service on the Chicago, Milwaukee & St. Paul R.R. ceased Saturday evening, Aug. 31, and was not resumed again until the morning of Tuesday, Sept. 3.

The accompanying views were taken at the time of the flood on Sept. 1 (in the afternoon), and the numbers referred to

*Previous articles on the recent floods in the Wisconsin River will be found in our issues of Aug. 8 and 29.—Ed.

FIG. 2. BLOWING UP TEMPORARY TRESTLE CAUSING A LOG JAM IN FLOOD AT WAUSAU, WIS.

are those of the cuts in your issue of Aug. 8, 1912. Fig. 1 shows the piers of stone masonry in place at the site of the wrecked dam of the electric power station. Builders in this locality are becoming very skeptical of concrete construction. We have had here, for some reason, very faulty work in this class of construction and it has been generally very unsatisfactory.

It was stated in the article in your issue of Aug. 29, that a trestle bridge had been built from the Barker & Stewart Island west to the mainland to handle the traffic temporarily until the time when a permanent bridge could be constructed. This was due to the washout of the steel bridge as shown in Fig. 5 of your article of Aug. 8. Fig. 2 shows the condition of this temporary trestle acting as a dam across the main channel with saw logs and flood trash piled high against it. This caused the water to flow across the Barker & Stewart Island, endangering the sawmill, and floating much lumber down the stream. Therefore it became necessary to dynamite this trestle bridge and log jam to let the water follow the main channel of the river rather than cross the island. Another view [not reproduced, ED.] shows the extent of damage done in the Barker & Stewart lumber yard, where entire piles of lumber have been floated from their foundations; it shows also a railway bridge almost awash that under normal conditions has 7 to 8 ft. clearance.

Fig. 3 shows the washout which was shown in your Fig. 6 of Aug. 8, and is interesting from the fact that this is the third time this filling or embankment has been washed out this season. The filling washed from place in this view has been carried down to the left of the bridge as shown in your former Fig. 6, and is cutting a material figure in closing the entire channel. Fig. 4 is taken from a position near the west end of the High Bridge, showing the coffer-dam in place and the water flooding the railway tracks and endangering other piers of that bridge.

The Wausau Street Ry. Co. and the electric power company are decidedly the heaviest losers near the city, although in view of the amount of water and the amount of repair work in course of construction the damage sustained is remarkably light.

At Merrill, Wis., it is reported the rainfall was about 5 in., and the repair work there was completely destroyed. This work consisted of masonry piers about 16 in. thick encased in a concrete shell about 3 or 4 in. thick. This construction did not withstand the force of the water until it had reached its highest point. If such structures as these are to be built on the Wisconsin River after the lesson that has already been taught by the flood of July 24, we wonder what might be said or done to cause these builders to have due respect for the might of the old Wisconsin.

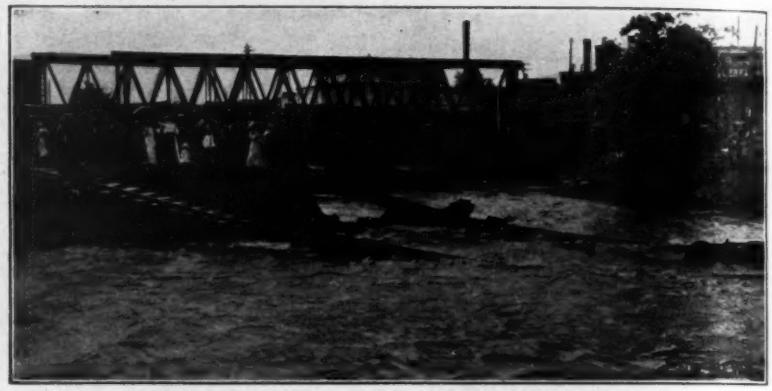


FIG. 3. WASHOUT OF RAILWAY EMBANKMENT AT WAUSAU, WIS.
(The High Bridge, Fig. 4, is shown at the right.)

One life was lost in the flood of Sept. 1. A milkman coming to the city on his regular tour drove off the bridge, which was covered with 2 ft. of water, over Jimmore Creek, just within the city limits on the north; and before he could extricate himself from the covered wagon he was drowned.

D. S. BURNETT,
Wausau Engineering Co.

Wausau, Wis.,
Sept. 7, 1912.

FIG. 4. FLOODING OF COFFER-DAM AND REPAIR WORK AT THE HIGH BRIDGE, WAUSAU, WIS.

Notes and Queries

In our editorial comment of Aug. 29, upon the recent grounding of the battleship "Arkansas" near Rockland, Maine, we stated that the pilot was reported to have been using at the time an old chart on which the ledge was not plotted. We are now informed that there was on board a late print, showing the ledge on which the battleship scraped.

A Water Filtration Plant for Kingston, Ont., has been recommended by the local board of health. It is reported that the board has twice requested the city council to install such a plant and that it recently adopted a resolution to the effect that if the plant was not installed within 30 days from Aug. 23 an appeal would be made to the Provincial Board of Health.

Issued Weekly by the
Hill Publishing Company
JOHN A. HILL, Pres. ROB'T MCKEAN, Sec'y.
505 Pearl St., New York.

Monadnock Bldg., Chicago.
6 Bouverie Street, London, E. C.
Unter den Linden 71—Berlin, N. W. 7.

CHARLES WHITING BAKER, Editor.

Subscriptions payable in advance, $5.00 a year for 52 numbers, including postage in the United States, Mexico, Cuba, Porto Rico, Hawaii, or the Philippines, $7.00 in Canada.

To foreign countries, including postage, $9.00 or its equivalent, 36 shillings; 36 marks; or 45 francs.

Notice to discontinue should be written to the New York Office in every instance.

Advertising copy should reach New York Office by Thursday of week before date of issue.

Entered at New York Postoffice as mail matter of the second class.

CIRCULATION STATEMENT

During 1911 we printed a total of 931,958 copies.

Of this issue 18,200.

None sent free regularly, no returns from news companies, no back numbers kept beyond current year.

Contents

Page

*Locomotives with Five and Six Coupled Axles.. 511
How Not to Introduce "Scientific" Management. 512
Sixth Congress of the International Association for Testing Materials..... 513
*Special Signal Indications on the Metropolitan Ry., England..... 521
*The Port and Harbor of Havre (France) 522
How the Chicago and Cleveland Street Railway Settlements are Working Out; Delos F. Wilcox. 526
*Sewage Treatment at Mt. Vernon, N. Y.; Charles A. Hammond..... 530
*Covering Worn Timber Piles with Cement-Gun Concrete..... 536
*Concrete Timbering for Mine Shafts; E. R. Jones..... 537
Electrolytic Action on Unreinforced Concrete; Cyril de Wyrall..... 539
*Double-Deck Cars in New York City and Pittsburgh..... 540
LETTERS TO THE EDITOR..... 541
Effect of Water Cooling on the Capacity of a Blast Furnace—*Another Flood in the Wisconsin River—Notes and Queries.
EDITORIAL..... 543
The Fire at Ocean Park, Calif.—Civil Service Examinations for Pavers and Rammers, Philadelphia, Penn.—The True Story of Steel Rail Failures—The Visit of American Engineers to Germany—May Concrete be Injured by the Action of Electric Currents?
Harbor Work of an Exceptional Character... 544
The Results Attained by the Congress of the International Association for Testing Materials..... 545
An Economic Study of the Lakes-to-the-Gulf Waterway Project..... 546
*Break in the New York State Barge Canal at the Irondequoit Creek Crossing..... 548
NOTES FROM ENGINEERING SCHOOLS.. 554
ENGINEERING NEWS OF THE WEEK.... 555
PERSONALS..... 556
ENGINEERING SOCIETIES..... 556
*Illustrated.

Engineering News

The great fire risk incident to jamming highly inflammable buildings close together in order to bring them within a few rods of the water front of ocean and other resorts, was forcibly illustrated by the fire at Ocean Park, near Los Angeles, Calif., on Sept. 3. It is reported that some 150 buildings were burned, causing a loss of many hundred thousand dollars. It appears that only one life was sacrificed, but that the number was not larger was due to chance. The press dispatches mention the "speedway" at Ocean Park. From having ridden over the "speedway" recently the writer of this note can attest that it is merely a narrow street, apparently made narrow as a part of the crowding policy of the real-estate interests which, from the Atlantic to the Pacific, are allowed to block sane city planning.

The extension of civil service examinations—or tests—to pavers and rammers in the Philadelphia Bureau of Highways must come as a shock to the old-timers of that city. It may be that some sort of an examination was gone through with before the present administration came in, but it seems unlikely that it tallied with the following description, which we take from an appreciative editorial in the Philadelphia *Ledger* of Aug. 28:

> The candidates were taken out of doors, where the work would not interrupt traffic, and there, under expert supervision, they were required to show what they could do. They were confronted with actual working conditions. They did—or failed to do—the work themselves—a very different matter from sitting in a cool and shady room and concocting an eloquent description on paper of how to do it.

This kind of civil-service examination, or test, as the *Ledger* well says, will commend itself to the general run of citizens, who have—and not without some reason—got the idea that all examinations are either "academic" or "fakes." What the public likes to call a "practical" test is essential to the extension of the merit system. Moreover, this applies to candidates for various administrative positions, including heads of technical bureaus or departments. In fact, the higher the position, the greater the need for giving practical experience and ability material weight in judging candidates for office—but that is another story.

The True Story of Steel Rail Failures

Our story of the genesis of "The Worm which Eats Steel Rails," on p. 406 of our issue of Aug. 29, has had the remarkable result of bringing us information from a gentleman who claims to have actually seen the ravages of this terrible insect. The gentleman forgets to sign his name; but the weighty importance of his letter has caused us to break our usual rule that anonymous letters go at once to the waste basket, and instead we print his letter below, *verbatim et literatem:*

> Dr Sr
>
> I see in your paper last week something in regard to a Iron Worm or Steel Grub as they are called, when I was roadmaster I had a good many Broken rails. And in three distinct cases. The core or heart of the rail was so badly eaten by thim that they broke A Bridge Foreman told me about a Iron Bridge that gave way & let a train through. That he examined some of Part of the Bridg after the wreck. & found several of these Grub's, They are about inch long and are yellow Brown color rusty looking so they are not a mith.
>
> Yours Truly
>
> B
>
> St Louis Mo
> Sept 6" 1912

ENGINEERING NEWS is delighted that almost simultaneously with the assembling in New York City of noted scientific engineers of all nations to discuss the most abstruse questions relating to the failure of steel rails, this journal can present a contribution from a "practical" man which reveals to the world the true secret of steel-rail failures.

We are obliged to add, however, that with an instinct worthy of Sherlock Holmes himself, a member of our staff has discovered that the handwriting of the above anonymous letter does not correspond at all with the spelling, punctuation, etc. In other words, we more than suspect that this latest reported specimen of the steel-eating worm, *ferro terribilis*, is not a "mith" but a fake.

The Visit of American Engineers to Germany

Unusual interest attaches to the announcement that the American Society of Mechanical Engineers is next year to visit Germany, by special invitation of the German Society of Engineers (The Verein Deutscher Ingenieure). This is by far the largest engineering society in the world, having over 25,000 members. The two societies will hold a joint meeting in Leipzig, June 23 to 25, 1913.

This invitation to American engineers follows close upon the reception given in the United States last spring to the German Technical Commission, which made a tour of the country under the leadership of Dr. Oscar von Miller, who

is the president of the German Society of Engineers.

This prospective meeting in Germany has greater significance than being merely a new opportunity for the exchange of courtesies between representative industrial leaders of the two nations. Prominent German manufacturers have promised to open to the inspection of the visitors, shops and industrial plants which have heretofore been hermetically sealed. The opportunity for American mechanical engineers to study German methods of manufacture and production is, therefore, a unique and unprecedented one and one which ought by all means to be taken advantage of by very large delegations of American engineers.

Those who are familiar with engineering practice both here and abroad realize that in most branches of mechanical engineering work, the United States is now lagging years behind the other industrial nations, while Germany, on the other hand, is universally conceded to be far in the lead. In painstaking thoroughness in design, in the application of scientific knowledge to the practical work of construction, in high quality of workmanship, and in skillful use of high-grade materials, Germany sets an example to all other nations. American mechanical engineers, therefore, should not neglect this exceptional opportunity to learn valuable lessons from German practice.

The Society expects to charter a special steamer for the accommodation of its members making the journey. Those who have the good fortune to take part in the excursion will doubtless find as great a measure of both pleasure and profit as did the members of the Society who took part in the International meeting in England in 1910.

May Concrete Be Injured by the Action of Electric Currents?

On various occasions we have published articles on the disintegration of reinforced concrete by the action of an electric current.* There is considerable inquiry as to whether plain concrete without reinforcement, may also be injured by the passage of an electric current through it. If any such action has taken place in the experience of any engineer, the facts and all the facts should be made public. For this reason, we have reprinted elsewhere in this issue one of the Testing Material Congress papers on the "electrolysis" of unreinforced concrete by Mr. de Wyrall, of the engineering staff of the New York subway.

While this paper was withdrawn by its author before presentation at the Congress session, it had already been made public by being printed and distributed to the membership, so that we violate no confidence in presenting it to our readers. It is proper to say further that its attempted suppression appears to us most unwise. Engineers want to know and are entitled to know *all the facts* about concrete. Vague rumors of trouble travel farther and faster and do far more injury than definite knowledge. Concrete is going to be used more and more anyway, and the more knowledge engineers have as to its properties, the more certainty they will have of being able to use it successfully.

And having said this, it is proper to say also that Mr. de Wyrall's brief paper is not by any means to be taken as conclusive. He makes the sweeping generalization that:

> The combination of electric current and water seems to act as a disintegrating agent on the cement, destroying its cohesion and reducing it to a paste which, when dried, can be pulverized with the fingers.

There is to be set against this, the results of many experiments to find any action of electric currents on mass concrete, all of which have shown negative results so far.

Before it can be concluded that the disintegration recorded by Mr. de Wyrall was due to electric action, it must be established much more definitely that no other possible causes of disintegration existed. It is, in fact, stated by Mr. de Wyrall that salt water was present in the case of the two walls reported as suffering injury. There may have been alternate wetness and dryness, or there may have been some foreign material in the concrete which acted in conjunction with the electric current to cause injury, or other causes may have operated.

Experiments upon the effect of electric currents on concrete, made under the advice of a member of the editorial staff of this journal, have appeared to show a forcing of dissolved chlorides into the mass of concrete test pieces. While no injury has resulted as yet, it is not certain what might result were the action long enough continued.

It would seem, therefore, that the Scotch verdict "not proven" must be rendered upon the indictment brought by Mr. de Wyrall. There is no need for engineers to be alarmed concerning concrete structures, nor is there need for the cement and concrete interests to be alarmed concerning the influence of his disclosures. Concrete is far too valuable and useful a material, and its reputation is too well established for one or a dozen instances of failure to shake our confidence in its reliability. The sensible thing to do is to set to work to find why these occasional failures do occur; and let us not be over hasty in jumping at conclusions.

*See Engineering News, Mar. 21, 1907; Dec. 24, 1908; Mar. 31 and Dec. 1, 1910; June 8 and July 6, 1911.

Harbor Work of an Exceptional Character

The great dock works which are now being carried out at Havre, France, and which are described elsewhere in this issue, present three features of exceptional interest in their character, apart from the very interesting features of engineering construction. These special features are as follows: 1, their great size and the provisions for vessels of over 40 ft. draft; 2, their location on a site reclaimed from deep water along the foreshore; 3, the use of a tidal basin instead of a closed or lock basin, in spite of the fact that the tidal range is 26.75 ft.

The development of harbors and commercial ports in Europe involves usually very costly and difficult works, and also works of a very different character from those employed in this country. These conditions are due in part to the great daily range of tide level, which necessitates, as a rule, the use of closed basins or docks having lock connections with the open water of the river or outer harbor. It is due in part also to the fact that works of this kind (with their deep foundations) involve great difficulties and cost, as compared with the construction of piers or wharves in open water. And further, the general tendency in Europe is to construct works of great massiveness and permanence. The term "port" includes works of two different classes: (1) the open-water space or harbor available for shelter and anchorage, and (2) the docks, piers and other facilities provided for the commercial use and accommodation of shipping. The developments at Havre cover work of both classes.

This place was established as a port for military (or naval) and commercial purposes some 400 years ago, the small vessels of that period being simply beached at some protected spot where repairs were required. As early as 1667, however, a closed basin or floating dock was formed by building a dam across a small creek, the entrance channel being fitted with two pair of gates to form a lock. In some of the more modern locks, however, only a single pair of gates has been used (with no lock chamber); this was owing to the peculiar tidal conditions, the period of high water lasting for about three hours, so that the gates could be kept open for that length of time. With the growth of trade new docks were built from time to time, until by 1880 all the available area of the scanty low ground between the cliffs and the shore had been utilized. When development was again needed, the only thing to do was to reclaim the foreshore and encroach upon the water. This was done on an extensive scale, the works being completed about 1890.

When still further development became necessary, conditions of shipping had changed materially; the "big ship" was a

matter of first consideration, and the "big ship" was increasing in size to a remarkable extent. It was recognized that works of an unprecedented character would be needed to provide accommodation for the vessels of the future trade. No land was available for such works, and the only possible solution of the problem was to build the works out into deep water. How this is being done is explained elsewhere, but it may be said that the new works extend nearly a mile from the shore and for a distance of nearly two miles along the shore. The basins on this great tract of reclaimed land are of stupendous size, having quay walls 3000 and 5000 ft. in length.

Perhaps the most interesting feature, however, is the fact that these great basins are not closed docks, but are open at all stages of the tide. When we consider that a tidal range of 26.75 ft. had to be reckoned with, and ships of 40 ft. draft to be provided for, we may conceive some idea of the foundations required for the new works. The arguments for the adoption of closed docks and open basins, respectively, are noted elsewhere, but the latter were considered to be the weightier and this system was adopted by the government engineers. It necessitated, however, the adoption of special means to meet a special condition incident to the fact that the harbor opens practically on the open sea, and not upon the still water of a river.

This condition is the prevention of unduly rough water and heavy swells in the tidal basin, and it is met by providing a large auxiliary or intermediate "stilling" basin between the outer harbor and the main ship basin. A deep channel will be formed through this auxiliary basin, but the sides will be left shallow and the sides of the basin may be in part revetted slopes. The principle of the design is that the combination of a comparatively narrow entrance and the shoal water in the basin will break up the sweep of the waves or swells and check their transmission, while the force will be expended on the revetted slopes without causing additional reflex waves, as would be the case with vertical walls.

So far as we know, nothing of this sort has been done before, and certainly not on any such scale as this. Just what the results will be can be determined only by experience, and that will not come for some years. Whether the currents or eddies set up will be such as to interfere with the maneuvering of the immense ships for which the new works are planned is a matter of conjecture. The port of Southhampton, in England, has some open tidal basins, but these are at some distance from the open sea and the tidal range is much less than at Havre.

The city and port authorities of Havre and the engineers of the French government who have had to do with the development of the new works deserve much credit for the broadness of their views and the boldness of their plans. We understand that work is barely commenced, and it is very certain that in carrying these plans into execution many engineering problems and difficulties will be encountered, and we may wish both the engineers and the contractors a successful termination to their labors.

The Results Attained by the Congress of the International Association for Testing Materials

Those who read the final resolutions adopted by the Congress of the International Association for Testing Materials, printed in our last issue, will doubtless have been struck by the very general and meaningless character of these resolutions, which are the net result of three years' work by the association.

One is inevitably led to question whether greater results ought not to be attained by an important international body of this character, and whether the large expenditure of labor, time and money in three years' work of this body is justified if the final results are so small.

To properly consider this question, we must note the fact that the work of the congress in bringing out and publishing information is not an essential or necessary one. The papers presented at the congress held two weeks ago, while of useful and in many instances highly interesting character, were all such as might have found ample publicity through other channels. The program of papers did not show, in other words, that the association is a necessary means of bringing out new information, and under these circumstances the presentation and publication of papers is only accessory, but not the main justifying reason for the association's existence. The only other reasons which can be offered for the existence of the body are its committee work, or rather the results of this work as expressed in positive action, and its social features.

The conviction has long been entertained by many careful observers of society and convention matters that organizations of very large scope, particularly those of international scope, have little value beyond their social side; that their principal function is to bring together, from widely distant places, men engaged in similar lines of endeavor. The importance of such bodies as a means of producing papers and other results of work and bringing them to public attention has been denied; and the idea that important advancement could be made through international committee work and the like has been questioned by asking for instances of successful work of this character. We regret to say that a careful analysis of the doings of the congress above referred to must convince the impartial observer that there is foundation for these somewhat pessimistic views.

There are many interesting possibilities in international coöperation, without doubt. Some of these, with direct reference to the International Association for Testing Materials, were suggested in these columns two weeks ago. We there expressed the hope that the congress might result in bringing definitely into nearer prospect the formulation of international specifications for our most important constructive materials; and we gave it as our opinion that no important obstacles stand in the way of attaining such international specifications.

There are wider possibilities than this, however. Unification in details, which may result even without formal action by adoption of standards or passing of resolutions, is also an important advantage. In many ways such a gathering might contribute toward removing unnecessary differences in methods and the conflict and duplication of work carried on, at different places, by men whose services to the world should be aided and not wasted in fruitless controversies over trifling differences.

None of these possibilities was realized by the Testing Materials Congress recently assembled in New York City. We may go farther and say that nothing done by that congress gave hope that such possibilities may be realized in the future. Let it be said here, however, that we have no desire to single out the Testing Congress as a special object of criticism, but that similar remarks would hold as to any of the other recent international technical congresses. We refer particularly to the Testing Congress only because of its recent date, and because of the full report of its doings which was given in our pages this week and the preceding week, enabling the reader to follow and compare our argument with the facts as presented by the assemblage itself.

In order to express our opinion more definitely, we may refer to the American Society for Testing Materials, a body also of large scope, engaged in the same endeavor as the International Association, and composed of men of the same class. It is known that this society has rapidly grown in membership and influence during the past ten years; that it has labored actively to attain definite useful ends, and that its work has materially aided the advancement of industry and the technical arts.

The International Association for Testing Materials has not achieved similar success, and it is not difficult to find the reasons. It appears that its general plan of action is to adopt no specifications or other standards on which there is any

dispute remaining. The standard must already have been agreed upon by all countries and all interests, so that a unanimous vote will be given in its favor, before the association will undertake to approve it. The Council of the association, comprising one man from each of the important countries of the world, makes it its chief duty to maintain this ultra-conservative policy. All controversial matters must be settled elsewhere than in the association or at the congresses. Whenever a point of difference arises, the mere fact that it is a disputed point is sufficient reason for suspending all action concerning it. The world must already have accepted a given matter before the association will accept it and standardize it with the seal of its official approval.

This course of action contains no promise of large achievement. Countersigning the world's established conclusions is not a very important nor a very useful occupation. In a few cases such approval might be distinctly serviceable if it came from a powerful body, whose opinion carried great weight and whose past performance gave it claim to rank as the leader and arbiter in its field. But the International Association for Testing Materials does not yet, unfortunately, occupy such a position. Its past performances of positive importance do not shine vividly in the minds of engineers. Its influence is nowhere apparent. In consequence, the stamp of its approval can carry but little weight. Whatever advantage might accrue to the world and whatever prestige accrue to the association from a formulation of a standard, or from approval of an elsewhere formulated standard before such a standard has been accepted by the world, is entirely missed and lost in an *ex post facto* standardization.

The American Society for Testing Materials does not follow such a barren course. If it had attempted to imitate the parent association in this respect, its history during the past ten years would have been markedly different. Indeed it is doubtful whether this society would be living today.

Had it avoided all contention, had it put aside for settlement elsewhere every contentious point that came before it, had it refused to take any action on matters that were still at issue, there would not be the live and energetic interest in the doings of this society that we see annually displayed. Its present volume of standard specifications would be nonexistent. If it had only adopted standard specifications, if all disputes had been settled elsewhere, its standards would not only be unnecessary, but they would be obsolete almost before they were printed.

Turning again to the International Association's work as summarized in the resolutions adopted by the recent congress, we find the result of three full years of work to be expressed in a large number of negative resolutions expressing vague sentiments in an inane way, plus two positive resolutions expressing affirmative conclusions. These two resolutions merit closer attention. It appears that one of them represents a series of scientific names and definitions, which are those already adopted and in general use by scientific men. The resolution seeks to standardize certain scientific definitions, facts and names. As these are already generally accepted, however, and as any tendency toward change in general practice would in no respect be affected or delayed by the association's resolutions, it is hard to see what possible value or utility this resolution can have. The other affirmative resolution proves to be a set of definitions for terms in common use in engineering circles. As far as the English form of these terms is concerned they do not agree with current usage and are undoubtedly doomed to failure as concerns general acceptance. As regards the German and French terms, in so far as the resolution recommends the terms already in general use it is superfluous, and in so far as it recommends changes in terminology it is very likely to prove ineffective.

These two resolutions, of no particular merit or force, are the sole result of three years' work of the International Association, carried on at large expense of money and labor, and involving the dead waste of much interest and attention on the part of several thousand important men scattered all over the world. The results do not justify their cost.

The value of these international congresses evidently must lie elsewhere than in the direct results of its labors. There can be little doubt that they lie exclusively in the social features of the gathering, for the technical discussion at the congresses themselves is necessarily brief and in many directions closely limited. The actual examination of the discussion held at the recent congress shows nothing to make this discussion preëminent either in amount or in cogency; nothing, in other words, that would not have been secured through the ordinary mediums of discussion, through the technical press or through local engineering societies.

An Economic Study of the Lakes-to-the-Gulf Waterway Project

If a capitalist were asked to invest money in the building of a railway line, the promoters would endeavor to show him accurate estimates by responsible engineers, first as to the cost of constructing and equipping the road, and second as to the volume of traffic which would probably be tributary to the road and the earnings which might be expected based upon such traffic. The same rule ought to apply when the public is asked to put its money into an enterprise to be carried out by the government, under either state or Federal direction.

The Lakes-to-the-Gulf Deep Waterway Association holds its annual meeting next week at Little Rock, Ark. It has for years been urging a Federal expenditure of upward of $160,000,000 to create a 14-ft. deep waterway from Chicago to New Orleans. In all the speeches and documents to which the Association has given birth, however, one will search in vain to find any accurate figures and facts proving that the waterway when completed would attract traffic enough to make the public a reasonable return on its investment in the shape of reduced transportation costs.

The Lakes-to-the-Gulf Deep Waterway Association appears to be long on claims, but very short on accurate knowledge of the enterprise it is promoting. It appears to be better at "slogans" than at cold facts and figures. In saying this, however, we do not intend to impugn the sincerity and good faith of the waterway promoters. They doubtless fully believe that the scheme they advocate would achieve all the success its advocates claim. As reasonable men, however, they should be willing to give careful and unprejudiced consideration to the presentation of its prospects.

We, therefore, take pleasure in recommending to the Little Rock Meeting of the Lakes-to-the-Gulf Association, and especially to engineers interested in the general problem of economic water transportation, a little book just published devoted to an economic analysis of the Lakes-to-the-Gulf project.* The author of the book, Mr. Wm. A. Shelton, made the investigation, of which the book gives the result, as a graduate student in economics at the University of Chicago; and the principal part of the book has previously been published in the *Journal of Political Economy*.

The reports of the Government engineers on the Lakes-to-the-Gulf project have been concerned chiefly with plans and estimates of the cost of constructing a 14-ft. channel from Chicago to New Orleans, which is the depth demanded by the promoters.

Mr. Shelton in his study has devoted himself to the traffic side of the problem. He has done just what the representative of a banking firm proposing to finance a new railway would do, viz, go over the line and see what traffic could be secured in competition with the lines now existing. More than this, however, he has given broad study to all the conditions governing the movement of traffic at all points along the Mississippi and Illinois

*Published by the author, Wm. A. Shelton, 6146 Greenwood Ave., Chicago.

Rivers, and his book gives the clearest and fullest explanation of the various conditions which influence traffic movement by water and by rail in the Mississippi Valley that has appeared anywhere.

It has often been pointed out in the columns of ENGINEERING NEWS that terminal and transfer costs are the largest item in handling traffic under present-day conditions. Both by rail and by water the cost of hauling between terminals has been reduced to an amazingly low figure. Mr. Shelton gives many illustrations of the operation of this rule. A cotton ginner on the Mississippi River near Greenville, Miss., does not ship his cotton to Memphis by water, for he would have to haul it three miles to the steamboat landing, and besides, the railway rate to Memphis is 7½c. per bale less than the cost of shipping by water when the cost of insurance and drayage at Memphis is added to the boat rate, as it must be to place the river and rail charge on the same basis. Besides this, the railroad company is a responsible concern. It will issue to the cotton ginner a through bill of lading, which is negotiable, and the cotton is compressed in transit when it is shipped to the final market beyond Memphis.

Again, the stock argument of the waterway enthusiast is that the waterways are needed to keep down the rail rates by their competition. Mr. Shelton's figures, however, show that the railways are now charging rates so low that the boat lines cannot compete with them, and, in fact, the inland water competition of which so much was heard a dozen years ago, has practically ended.

In 1871 the total amount of freight received and shipped at St. Louis was 1,655,000 tons by river, and 3,258,000 tons by rail. In 1880 the river traffic had grown slightly and reached 1,931,000 tons, while rail freight grew nearly threefold, reaching 8,852,000 tons. By 1895 river traffic had fallen to 812,000 tons, while the rail business was nearly 20 times as great, or 15,838,000 tons. In 1910, only 192,000 tons of river traffic remained, while the rail traffic attained a total of 51,720,000 tons. It is not reasonable to suppose that railway traffic managers in fixing freight rates today pay any attention to the trifling traffic still carried by the river boats, made up chiefly of such low-grade materials as logs, coal, sand, and stone.

Mr. Shelton further shows that the average rate actually charged on corn, wheat, and oats, by the Illinois Central R.R., between East St. Louis and New Orleans, is only 2.67 to 2.92 mills per ton mile, and also that rates substantially as low as this are charged by the railway *from shipping points not on the river*, so that it cannot be successfully claimed that these low rates are the result of water competition.

Further, these rail rates are practically as low as the rates for shipments by water on the Rhine River in Germany, without including the cost of insurance on the river freight or the cost of maintaining the waterway.

There is a general idea current that the decay of river traffic is due among other things to the fact that the river vessels are unsuited to modern conditions, and Congress has even appropriated half a million dollars for the building of experimental boats to demonstrate how traffic can be successfully moved on the Mississippi at low cost. Mr. Shelton's study, however, indicates that the causes of the decadence of river traffic lie deeper by far than the use of primitive types of boats and primitive docks and wharves. The railway can switch its cars directly into the yards of the factory or the mine or the warehouse, whether it is a mile or ten miles or a thousand miles from a river steamboat loading. By no possible means can the river send out similar spurs to the sources of traffic. In this one feature of the elimination of rehandling and road hauling, the railway has an advantage over the river that no possible change in boats or in channels can overcome.

The book is replete with facts, figures, and data, bearing upon this subject, just the sort of information, in fact, which engineers frequently ask us to present in these columns. We forbear to take space for its further abstract, however, other than to reprint the final conclusions reached by the author as follows:

The writer has been asked frequently what his conclusions are concerning the Lakes-to-the-Gulf Deep Waterway. Hence an attempt is made here, following the concrete study of the preceding pages, to state briefly the general conclusions that seem to be supported by the evidence already presented.

In the first place, the cost of even a 14-foot waterway is not insignificant. The engineers have estimated a cost of, roughly, $160,000,000 for the construction of the channel from Joliet to New Orleans and more than $6,000,000 for annual maintenance. At a very conservative estimate, $100,000,000 additional would be necessary to complete the channel from Chicago to Joliet, and the maintenance, including the dredging of the channel for sediment deposited from the sewage of Chicago, would probably amount to some three or four million dollars annually. These items would foot up more than a quarter of a billion dollars for construction and approximately $10,000,000 annually for maintenance. We are accustomed to considering these amounts as insignificant but if we take one example of what could be done with this amount of money, it will be seen that the amount of value represented is not inconsiderable.

The average capitalized value of American railways is a little less than $60,000 per mile, and this is usually considered an excessive capitalization. If $40,000 more be added for the second track, the value of a mile of double-track railway would be $100,000. The distance between Chicago and New Orleans is less than 1,000 miles by several of the rail routes. It would thus cost only $100,000,000 to construct a double-track freight line tapping the important cities on the route. Twenty-five millions of dollars could be expended for freight equipment, the remaining $125,000,000 could be given to charity, the $10,000,000 for annual maintenance of the waterway would probably defray the expense of up-keep of both the railway and equipment, and the only cost that the rates for carrying freight on this specially equipped double-track railway would be required to cover would be the cost of operation.

On such a railway, operated by the government for freight service only, could be carried both low-grade and high-grade freight, and the rates could be made almost anything—certainly lower than could be made on a waterway between Chicago and New Orleans. Of course it would not be fair to stockholders of the railways paralleling the route to construct and operate such a railway through the government, but the case serves to illustrate both that $250,000,000 is an important amount of money, and that the necessity of constructing artificial waterways has passed.

The lower Mississippi River is now a more efficient waterway than could reasonably be constructed between Chicago and New Orleans. The lower river is wide enough to carry barge fleets of any reasonable dimensions, while the several sections of channel contemplated between Chicago and St. Louis could not be used for important barge fleets. Moreover, the speed of vessels other than barges would be much less on the upper route than at present on the lower route. These conditions make the lower river more efficient than the northern section could be made. But even on the lower route, the barge lines have been unable to attract the competitive freight from the rail lines. The Mississippi Valley Transportation Company, to be sure, made an attempt to revive the river traffic between St. Louis and New Orleans in 1911. A tow with a modern steel barge made six round trips and carried more than 10,000 tons of freight; but so far did the company fail to meet expenses that it was forced to go out of operation, even before the end of one season. It may be possible to establish a line that carries through freight in competition with the railways on the lower river; yet in 1904 the old barge line was forced to give up a long-established traffic, and in 1911 defeat was met by a modern barge line. It is yet to be decided whether a boat line can operate successfully on the lower river carrying freight in competition with the present rail service.

If, then, the more efficient channel of the lower river is of doubtful economic value, why should the American nation construct at a large cost a channel that would be of little or no value? Moreover, in constructing the upper part of the route, an important obstruction to transportation would be effected. Almost all of the hundred bridges spanning this section of the route would require reconstruction; to allow for increased width and boat clearance. This burden would fall on the city of Chicago, the municipal railways of Chicago, other steam and electric railways, and the counties along the route that maintain public highways across it. The future construction of electric and other railways in this thickly populated and rapidly growing section would also be retarded by the additional cost for bridges. These are some of the reasons that make the writer believe that it would be a pure economic waste to construct a Lakes-to-the-Gulf Deep Waterway.

In conclusion, if the channel should be used to some extent, and should cause

slightly less cost for transportation to certain favored shippers, situated along the route and shipping commodities that could be carried on the waterway, it would even so be questionable social policy for the nation to bear the burden of shipping for a favored class. If the saving were to be equal to the expenditure, and were not to take from vested interests in railways, the project would still be questionable; but if as the writer believes, the saving to the favored shippers would not be equal to the expenditure, then the policy of taking from the people as a whole to aid a special class is indefensible.

Break in the New York State Barge Canal at the Irondequoit Creek Crossing

One of the most noteworthy pieces of construction on the new Barge Canal of New York State was partly destroyed on Tuesday, Sept. 3, 1912. About 11 miles east of Rochester the Barge Canal, occupying the location of the old Erie Canal (Fig. 1), crosses Irondequoit Creek on an embankment about 60 ft. high, the creek being carried through in a culvert of ancient date and varied history. The canal broke directly over the culvert, and about 500 lin.ft. of the embankment was washed out. At this point the canal lining is a concrete trough, 96 ft. wide, about ¾ mile long, which, together with the relocation and sand embankment work just west of the break, forms a specially notable feature of the new canal. The trough over the break was wrecked.

The accident fortunately involved no loss of life. The money damage will be about $200,000, cost of replacement; to this must be added the damage to lands below by the wash of sand from the break, which was carried as much as a quarter mile downstream.

A succinct account of the break is quoted from the Rochester *Democrat* of Sept. 4:

> A gang of 25 men was engaged at the time of the break in putting a jacket of concrete inside the arch of the culvert. The annihilation of all was averted by the alertness of Michael Sweeney, foreman. At 8:30 yesterday morning Sweeney saw a stream of water pouring out of the side of the culvert arch, and climbed the embankment to see what was the trouble. He reached the big conduit in time to warn the men. All immediately reached points of safety, except one laborer who held back until the bank gave way. He was buried in the deluge of sand and water, but he was rescued by his fellows.
>
> After foreman Sweeney discovered the leak and gave warning to his men, he telephoned to Superintendent Leddy. Orders were given to close the new guard lock at Cartersville and the old guard lock at Bushnell's Basin, about a mile apart. Superintendent Leddy said trouble had been indicated by the canal current some minutes before the break occurred and he had been notified that something was wrong. Patrolman George Schaefer said he went over the section at 8 o'clock and saw no indication of trouble, but a little later he noticed that the current in the canal had been reversed.

This account is materially modified by other facts, contained in the Consulting Engineers' report printed at the end of the present article.

One serious result of the break is that through traffic on the canal will be interrupted at least a month or six weeks, and probably all the rest of the season. The present time is an active shipping period.

A precise description of the break, directed mainly to the probable causes, has been written for us by T. W. Barrally, Rochester, N. Y. We follow it with some fuller notes on the constructions involved, from data given by Emile Low, Buffalo, N. Y.

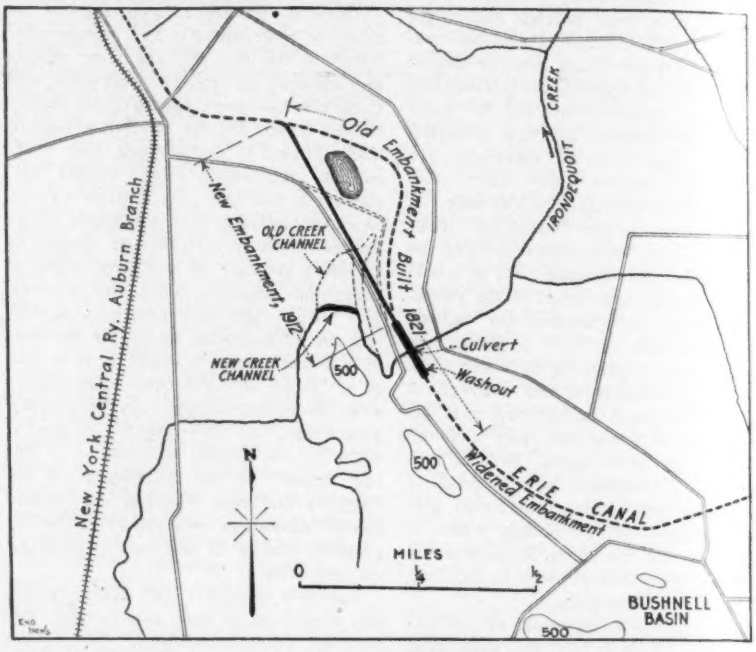


FIG. 1. SKETCH MAP OF ERIE CANAL AND NEW BARGE CANAL AT CROSSING OF IRONDEQUOIT VALLEY, EAST OF ROCHESTER, N. Y.

Probable Causes of the Irondequoit Culvert Break

BY T. W. BARRALLY*

On Sept. 3, 1912, about 9 a.m., a break occurred in the Erie Canal at culvert No. 30, near Bushnell's Basin, N. Y. Practically the entire embankment over the culvert was carried into the valley below, and about 540 ft. of the new concrete canal trough was destroyed.

The Erie Canal at this point crosses the valley of Irondequoit Creek on a high sand embankment. Continuing westerly from the creek crossing, the old canal runs in a reverse curve to Cartersville. In the new Barge Canal the westerly loop of this reverse curve is eliminated

*Engineer and Contractor, of Barrally & Ingersoll, Powers Bldg., Rochester, N. Y.

FIG. 2. IRONDEQUOIT BREAK IN NEW YORK STATE BARGE CANAL, SEEN LOOKING NORTHWEST ALONG CANAL TROUGH

(Break discharged to right of view; opening in north slope of embankment about 250 ft. wide; break in floor about 500 ft. long.)

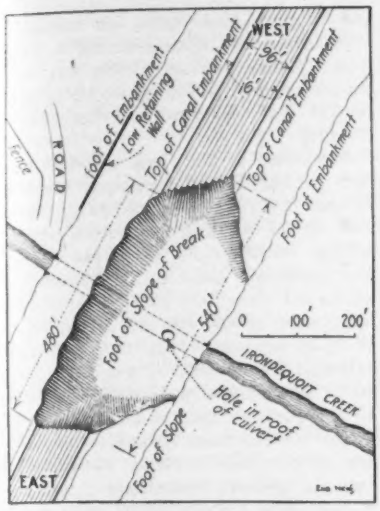


FIG. 3. SKETCH PLAN OF IRONDEQUOIT BREAK, NEW YORK STATE BARGE CANAL

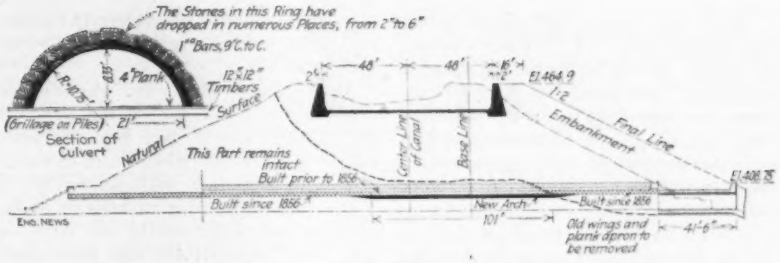


FIG. 4. IRONDEQUOIT CANAL EMBANKMENT AND CULVERT

(Based on a drawing made at time of arch reinforcement, Jan.-Feb., 1912.)

by the construction of a sand embankment running in a straight line across the chord of the curve.* This embankment has a puddle facing, over which is placed rip-rap stone construction; the new canal will form a pool between the new embankment and the old Erie Canal embankment. The easterly loop is eliminated by the construction of a sand embankment built in a straight line, as in the case of the westerly loop, but the canal is carried on top of the embankment by means of the construction of a concrete trough. This trough is composed of vertical walls on either side of the prism, 96 ft. apart, with a waterproofed concrete floor. The concrete trough construction was extended easterly along the entire embankment across Irondequoit Creek fill, the construction at the latter place being made on the existing alignment.

Culvert No. 30, carrying Irondequoit Creek under the canal embankment, is a masonry arch of about 21 ft. span, resting on a timber grillage. The original arch, about 250 ft. in length, was built prior to 1856. The center of this structure had become weak and was reinforced for a length of about 101 ft. with a stone arch built inside the regular arch. During the canal enlargement subsequent to 1856 the inner arch was extended the entire length of the original arch and also about 100 ft. to the south to meet the requirements of the enlarged canal embankment. Recently a reinforced-concrete arch was placed in the center of the structure inside the second arch, and the floor of the culvert was also covered with concrete the entire length.

At the time of the break, the contractor had excavated at the downstream end of the culvert for the purpose of making an extension of 41 ft. called for by the Barge Canal plans.

South of the canal, at a distance of about 200 ft. upstream, there is a low dam across the creek, forming a pond, which has been in existence for many years, and a small grist mill operates by water power there. A seepage of groundwater under the head of the dam reaches the foot of the embankment and flows along the line of the culvert. This condition has been observed by engineers in charge of construction for a long time and has probably always existed. There were no cutoff or stop walls, and probably none were planned in connection with the new construction. Saturation of the bottom of the embankment around the culvert causing a flow in the direction of the culvert toward the outlet was undoubtedly increased by the cutting off of the wings and head walls and excavating around the outlet for the purpose of constructing a concrete-arch extension.

Experience on the Western Division during Barge Canal construction, on that part where the improvements are along the existing Erie Canal, has shown that nearly all breaks occurring have been at culverts whose foundations were not resting on rock.

*In the sketch map, Fig. 1, the west cutoff embankment is not shown.—Ed.

FIG. 5. VIEW OF EMBANKMENT AT IRONDEQUOIT CREEN, LOOKING SOUTH; BREAK IN MIDDLE OF VIEW

During the earlier part of the Barge Canal construction, the frequent breaks in culverts resting on timber foundations led to the recommendation that all culverts on the 60-mile level west of Rochester should be removed, and culverts constructed of iron pipe cased in concrete and having stop walls on either end were substituted.

It is clear that the break at Culvert No. 30 was caused by the gradual weakening of the arch. Its foundations had been gradually weakened by the weight of the embankment, the lower part of which was saturated with groundwater; the dropping of the ring stones in that part which was recently reinforced with concrete indicated a gradually failing structure. The flow of groundwater along the barrel of the arch was probably augmented by the operations of the contractor excavating at the outlet end of the culvert.

These causes produced a gradual settlement of the embankment over the culvert and under the trough sufficient to open a joint in the trough, and failure followed.

The sketch herewith, Fig. 4, shows the construction of the canal taken through a section on the axis of the culvert. The single-hatched part shows the original arch built prior to 1856 and also the arch built within the original structure to protect it from failure. The extension of the culvert at the time of the canal enlargement later than 1856 is shown in double hatching. The new arch ring of reinforced concrete built to strengthen the double masonry ring of stone and recently completed, is shown in full black. The plan also shows in dotted hatching the proposed new concrete-arch extension which was in progress at the time of the break.

An examination of the photographs taken of the break and of the work on the ground shows that the construction of the concrete trough was in every respect of first-class workmanship.

The vertical walls were built in 30-ft. sections, and entire blocks are now intact. The keyways are also practically intact except where injured by one block falling upon another.

Additional Data

Some additional facts as to events just before the failure, and as to the condition of the work determined from examinations after the failure, are given in the report of the Board of Consulting Engineers, printed farther below.

A sketch plan of the break is given by Fig. 3 (E. Low), and a profile of the break in the embankment cross-section, Fig. 4 (T. W. Barrally).

The Irondequoit Crossing

To explain the nature of the structures at and adjoining the break it is necessary to go into a short review.

It happens that the stretch of canal across the valley of the Irondequoit is in some respects one of the most interesting parts of the canal. The location, swinging in a large curve southerly from Fairport to Bushnell's Basin and thence again north to keep along the hill slopes, crossing the creek bottoms with heavy embankment, and passing westward out of the valley beyond Pittsford, was made by James Geddes in 1808, and in spite of half a dozen or more changes of plan and changes back again, no extensive modification was made until the present Barge Canal location. Even now the change is only the straightening of two curves just northwest of the creek crossing.

The canal at the creek crossing was built in 1821. The Irondequoit culvert as then built was a semicircular stone arch of 26 ft. span, resting on timber grillage on piles. Its length was 245 ft. Quicksand was met in the foundation work, and some 900 piles, 12 to 20 ft. long, were driven. A new culvert, 324 ft. long, was built when the canal was enlarged, about 1854. It was segmental, of 23 ft. span and 9 ft. rise. The new arch, apparently built inside the old one, seems to have been constructed in several stages (see sectional sketch, Fig. 4). No general reconstruction appears to have been done in the 90 years since the culvert was first built.

For the present Barge Canal improvement, the necessary widening of the embankment required the culvert to be lengthened. The lengthening was started only within the last few weeks, however, although the canal trough itself was completed early this year and was in service this season.

At the same time, some strengthening was done, earlier during the present year (January to May, 1912), in the central portion of the culvert, by putting in a shell of reinforced concrete. As in the case of the former repairs, the strengthening was built inside the old work. The sketch section of the culvert in Fig. 4, taken from a drawing made for the recent strengthening operations, shows that the masonry had settled considerably, many of the arch stones being shifted, which indicates something less than ideal stability. This refers to the second or segmental arch.

The canal embankment and trough also require a brief reference. At the point of break the new Barge Canal is lined with concrete in the manner shown by Fig. 6. This lining was designed by the Advisory Board of the Barge Canal about three years ago for the cutoff embankment, but was later extended eastward over the culvert portion.

The Irondequoit valley crossing was improved under the Barge Canal plans by two very large cutoff embankments. The west embankment cuts off the southward curve near the left side of the map Fig. 1, and is not shown. It forms the north bank of the new canal, the water being ponded between the new embankment and the old canal. It is 16 ft. wide on top, with side slopes of 1 on 3. 55 ft. high at the maximum, built of sand, with gravel and soil covering on the north or air face; a clay lining on the water face was originally contemplated, but was omitted.

The east embankment, shown on the map, Fig. 1, carries the new canal on its top. It cuts off the northward curve of

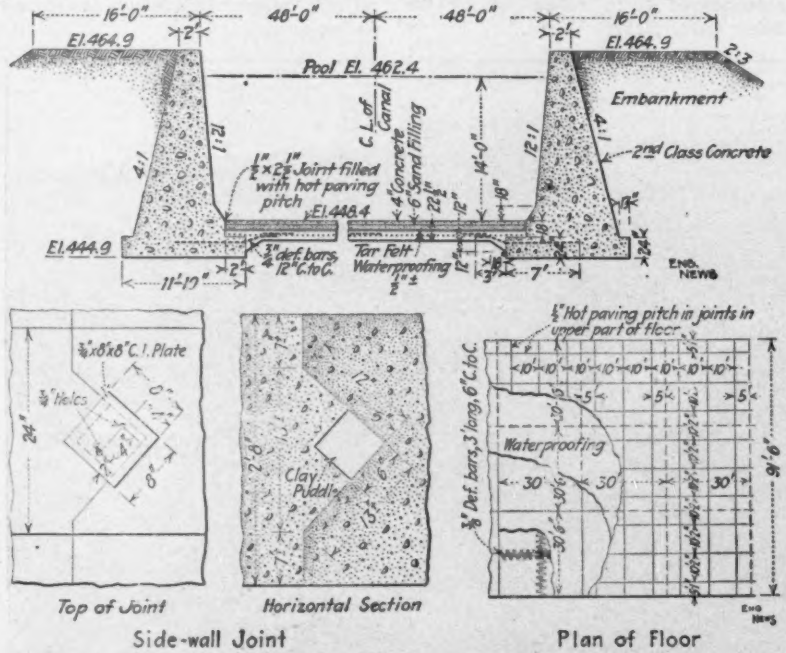


FIG. 6. SECTION AND DETAILS OF CONCRETE TROUGH OF BARGE CANAL AT IRONDEQUOIT CROSSING

the Erie Canal around a loop of the creek, anl is about 2800 ft. long. The creek was diverted by a channel cut across the neck of the loop, and the embankment built by hydraulic spreading and by direct steam-shovel work over the bottom lands and through the abandoned creek bed. The embankment was built several feet above final level, to allow for settlement. The material is sand. This embankment is 58 ft. in greatest height, 182 ft. wide on top, and about 436 ft. wide on bottom.

The old Erie Canal has a wooden lining. For the east Irondequoit embankment of the new Barge Canal a concrete trough construction was designed, which as modified by the Advisory Board in 1910, is of the section shown by Fig. 6. The sides are gravity retaining-walls, and the bottom is of concrete plates in two layers, with waterproofing between. It was built in 1911 and 1912. Its condition is said to be excellent, the concrete showing solid and firm, with smooth faces, all in true alignment and level. At the break the separate sections fell without breaking, and exhibit good workmanship.

The side walls of the trough were built in 30-ft. lengths, with clay-rammed joints as shown in Fig. 6. The bottom was built as follows: The lower 12-in. layer

FIG. 7. LOOKING SOUTHEAST ACROSS BREAK

of concrete was laid in 30-ft. squares, with tar paper in the joints. These squares are tied to the sidewalls by reinforcing rods, but otherwise are unreinforced, except for rows of short rods directly under the joints of the upper layer and transverse to these joints. On the lower layer was placed a five-ply felt-and-pitch waterproofing, on this a 6-in. sheet of sand, and on the sand the upper layer of concrete. This latter, forming the surface of the floor, is 4 in. thick, unreinforced, and laid in 10-ft. squares, with joints poured with hot pitch.

The design as executed is not exactly according to the Advisory Board's recommendations, which fixed different thicknesses for the two layers of floor concrete (4 in. and 5 in., respectively). The waterproofing was substituted by the Board for a layer of clay puddle under the floor, and the division into squares and the joint construction of floor and side walls were fixed by the Board. Also the trough was made 2 ft. deeper than previously planned.

The break occurred something more than 500 ft. east of the point where the east cutoff embankment joins the old canal embankment, and thus is entirely an old embankment. This old structure was widened to accommodate the increased width of the Barge Canal, and the concrete trough was extended for a considerable length eastward on the old embankment. The method of doing the widening was to excavate the enlarged (widened and deepened canal prism) by steam shovel, and cast the spoil over the *north* slope, to widen out northward only. The south face was maintained without shift.

The old embankment, having a new slice added on its north slope, was not homogeneous. Clear evidence as to the raw condition of the added slope material is contained in the consulting engineers' report, farther below. A specially important point, however, is the fact that the new slope could not have been completed at the culvert, as the culvert arch was not yet extended. We therefore, in Fig. 4, indicated the lower part of the slope by a dotted line (showing the final line), as a reminder that the actual slope at the culvert was steeper, an unknown amount. It appears from the consulting engineers' report that this slope may be estimated as 1:1; but, in view of the extensive rutting and wash elsewhere along the north slope, it is possible that the effective slope at the culvert was even steeper.

The retaining-walls of the concrete trough rested on the older part of the fill. The southerly one had its toe some 40 ft. inside the old slope, but the toe of the north retaining-wall was considerably closer to the slope, though yet on undisturbed old embankment. Concerning this old embankment a Barge Canal report a few years ago used the phrase:

> The present embankment has been in place many years and is, generally speaking, in stable condition.

That leakage of water from the old canal through the wooden lining and down through the embankment was more or less continuous may be appreciated. At Irondequoit Creek culvert such leakage was often quite obvious and alarming. It is believed that the lower parts of the embankment near the culvert, through the joint action of canal water and leakage water from the upper part of the creek seeping through the embankment instead of passing through the culvert (see T. W. Barrally's article above), were frequently quite wet. The effect on an embankment in this condition, of the excavation in progress at the north (downstream) end of the culvert to build the extension of the culvert, can only be conjectured.

The above descriptive statements give all the evidence available at the present writing on the question of the parts played by the three structures involved in the break: the culvert, the embankment, and the concrete trough.

The condition of the embankment after the break is illustrated by the photographic views, Figs. 2, 5, 7-11, and the sketch plan Fig. 3, herewith. The crater-like gap in the embankment, about 500 ft. long on the canal center line, has its bottom slightly above the level of the culvert roof. The south slope of the embankment is still standing undisturbed, practically to the original crest level. The discharge was wholly to the north or downstream. At the lower end of the culvert the sand is up to the culvert top, about 20 ft. deep, while some 1200 ft. downstream the sand deposits are 6 to 8 ft. deep.

The break was investigated four days after the accident by the Board of Consulting Engineers connected with the State Engineer's office. Through the courtesy of J. A. Bensel, State Engineer, we are able to present their report:

Report of Consulting Engineers

In accordance with your instructions we made, on Sept. 7 and 8, a thorough examination of the conditions as then existing of the break in the Barge Canal, which occurred on Sept. 3, at the Irondequoit Creek culvert, near Bushnell's Basin, including in this examination conferences with those persons who were at or near the site of the break in the canal when it took place, with the exception of one or two employees, whom we were not able to find. Our examination covered not only all parts of the wrecked canal structure at the site of the break but also the condition of the prism and the embankments for a considerable distance east and west of the break.

It appears that the working force had been engaged about ten days prior to Sept. 3 in extending northward the barrel of the Irondequoit Creek culvert a distance of 41.5 ft., the work of lining the old part of the interior of the culvert with a thickness of 12 in. of concrete having been completed last spring. This work of extension of the culvert necessitated excavation in the bed of the creek for a distance of somewhat less than 90 ft. along the extended axis of the culvert. Within this excavation, but not within 15 ft. of the old headwall, about 40 piles had been driven for the foundation of the northern part of the contemplated work.

We were informed that the Superintendent of Public Works had issued regulations forbidding any blasting in the excavation for the extension of the north end of the culvert. It was alleged to us, however, that blasting for breaking up the cemented gravel in the excavation adjacent to the north end of the channel had been done at various times, and even in the early morning of the day on which the break occurred. The evidence as to this point is not conclusive, although it was strongly alleged that such blasting had been done.

You are aware that under Contract No. 63 a large addition had been made to the northerly side of the embankment carrying the canal at this point in order to afford a proper support for the enlarged prism of the Barge Canal. The slope of this additional embankment was made in general 1 vertical on 2 horizontal. As the toe of this new slope was necessarily carried about 40 ft. beyond the toe of the old embankment, and as the barrel of the Irondequoit Creek culvert was not extended at that time, the toe of this new embankment on either side of that culvert was necessarily drawn in to the face of the latter, making the new slope above the crown of the culvert, as nearly as can be estimated, about 1 vertical to 1 horizontal and possibly a little steeper.

About 8:30 o'clock in the morning on Sept. 3, Leveler J. B. Doyle observed a trickling stream flowing down the embankment and over the headwall of the culvert a little on one side of the crown. He immediately went up the bank, following the course of the small stream, until he reached a point vertically over the culvert and about 10 to 12 ft. below the towpath, where he found a small stream emerging as from a spring, with saturated material around it. He found that the towpath had already settled about 18 in. below the top of the concrete sidewall, that wall apparently not having settled up to that time. He hailed an approaching yacht and turned it back in its course until it had passed the nearest guardgates to the west, which he hastily closed as a precautionary measure, without expecting, however, immediate failure. Within a few minutes after closing these gates the water rapidly settled in the adjoining section of the canal leading back to the culvert, indicating that the break had occurred.

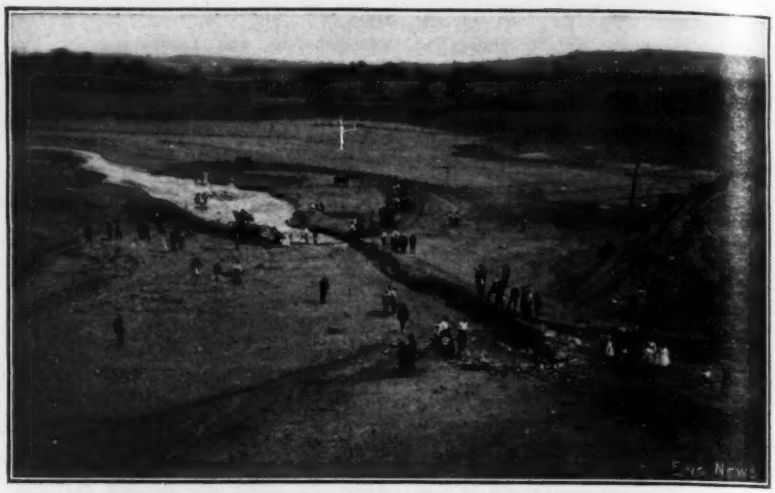


FIG. 8. LOOKING NORTHEAST DOWN THE VALLEY OF THE IRONDEQUOIT. END OF CULVERT IN THE MIDDLE OF VIEW

FIG. 9. BREAK IN CONCRETE TROUGH; LOOKING WEST

It was reported to us that after the northerly bank had first failed, one or two men employed on the work at the culvert noticed, for a moment at least, the concrete sidewall of the prism apparently exposed to its full depth where the surface of the bank had already slid down to the north end of the culvert. It seems clear, from our investigation, that whatever may have taken place in the interior of the bank, the first obvious part of the failure was the north slope immediately over the culvert.

We made an extended examination of all parts of the wrecked concrete structure of the prism of the canal and of the faces of the bank remaining in place on either side of the break, for the purpose of discovering, if possible, any defect of material or workmanship in any part of the work exposed to view. We made search especially to discover any evidence which might exist of a leakage through the joints of the sidewalls or of the bottom of the canal prism, but we failed to find any such evidence at any point. The concrete of both the wrecked sidewalls and bottom of the canal shows it to be hard, impervious and strongly resisting. The destructive torture to which parts of the walls and bottom were subjected by the rush of the waters and by the overturning and collision of the concrete parts disclosed nowhere any more damage than might have been expected if the masses of concrete had been corresponding masses of hard, sound rock. We noticed particularly the effectiveness of the steel reinforcement of the joint between the inner toe of the vertical sidewall and the bottom 12-in. mass of concrete. In a number of cases that joint had successfully withstood the destructive effects of the wreck and was intact, in some instances, without evidence even of separation. The water-

FIG. 10. LOOKING NORTHWEST THROUGH WASHOUT

FIG. 11. NEARER VIEW OF BREAK LOOKING NORTHWEST

proof joints in the parts of the bottom adjacent to the break but out of reach of influence appear to be in completely satisfactory condition, without openings or other disturbances. As the south embankment remained in place nearly to its full height, the overhanging parts of the floor and north wall cover a long oblique face of the supporting filling immediately under the canal floor. This face of embankment filling, performing the immediate function of supporting the floor of the prism, was practically vertical throughout the entire break on both the east and west sides. We failed to discover any point throughout the whole extent of the two wrecked faces bearing any evidence whatever of the softening of that filling by leakage prior to the break. The vertical face stood with a height in some cases of not less than 8 ft. intact and firm, with every appearance of solidity and without any softening effect which would have appeared if there had been any leakage through the canal floor. Moreover, the under surface of the 12-in. course of concrete, where exposed, was in all cases dry, while the water was running over its upper surface and where the upper 4-in. slab was badly damaged or displaced. In fact, the results of our examination indicate that the design of the concrete work of the canal prism is suitable and effective for its purpose and justified by the manner in which it has performed its duty. Moreover, the quality of the concrete, as already stated, is entirely satisfactory and shows that it has been fabricated and put in place so as to perform effectively the service for which it was intended. The exposed bank under the floor of the canal and under the foundation courses of concrete of the sidewalls exhibits firm and unyielding supporting power. We found no evidence anywhere indicating that the material of the immediate foundation beds for both sidewalls and bottom of the canal is not well adapted to its purpose and worthy of unqualified confidence as supporting material.

Water had been leaking into the old culvert through the bottom and through the upper parts of the barrel for a considerable number of years prior to the completion of the concrete prism. In fact, this entrance of water into the culvert through the bank underneath the old canal bed was so great a year and a half ago that grave apprehension was entertained for the safety of the bank immediately over the culvert, and those apprehensions led to the interior lining and strengthening of the culvert, to which allusion has already been made in this report. It is impossible that the flow of water through the bottom and barrel of the culvert could have been going on for so long a period without deteriorating that part of the bank at least immediately in contact with the sides and top of the culvert. It is obviously impossible to determine now how large a part of the bank over the culvert was injured by this seepage of water through it, as nearly all the material over the culvert has been washed away except a relatively small part over the southerly end, but the injury to the embankment by this means must certainly have been material and sufficient to play an important part in the destruction of the bank in case of the yielding of any part of the embankment in this immediate vicinity.

Heavy rains took place on the afternoon of the day before the disaster and on the preceding day. There had also been some heavy rainfalls in that vicinity during the month of August.

Our examination of the tops and north slopes of the canal embankment both to the east and west of the break shows marked effects of the softening and settling of those parts of the slopes by the rains which have fallen upon them since they were put in place. There are long stretches of perhaps 250 ft. of longitudinal cracks, besides many washed-out gullies down the slopes as deep as 3 to 6 ft. Easterly of the break there are cracks of this character running not less than 250 ft. longitudinally along the edge of the northerly slope, although the subsidence at no place has been more than 10 or 12 in.

This evidence, taken in connection with the statements of Leveler Doyle and others, appears to us to indicate with strong probability the origin of the break. The heavy rainfall which occurred the afternoon before the break had, without doubt, saturated and softened the slopes of the bank. The cracks in the embankment which now exist on both sides of the break, and which undoubtedly existed at many points on the slope, would receive and retain considerable quantities of water, fully sufficient to account for the small stream which was seen escaping from the face of the embankment and running down to the culvert. The steep slope of at least 1 to 1 at this point induced a slide of the softened mass, seriously aggravated by the weakened material over the culvert, in sufficient volume to expose the sidewall of the canal trough vertically over the culvert, which wall, losing its support by this slide, would settle sufficiently to cause a break or opening in the canal prism from which water would begin to escape and be followed by a rapidly increasing outward rush, producing in a few minutes' time the complete wreck as it exists. What part was played by the weakened portion of the bank over the culvert caused by years of seepage through it

of water from the old canal must, of course, remain unknown, but it might have been a controlling influence after the initial slip of the softened material along the line of the steep slope above the culvert. It is not impossible that it may have been the initial point of failure, although it would appear from the available evidence that the initial motion took place in the softened material of the steep slope. In fact, if there had been no culvert the break would not have occurred.

If the alleged blasting of the cemented gravel in the excavation immediately adjacent to the north headwall of the culvert actually took place, in violation of the instructions of the Superintendent of Public Works, the jar and vibration incident to it would be an aggravating influence in aiding the failure.

JOSEPH RIPLEY, Chairman,
M. G. BARNES,
WM. H. BURR,
G. S. GREENE, JR.,
T. KENNARD THOMSON,
Consulting Engineers.

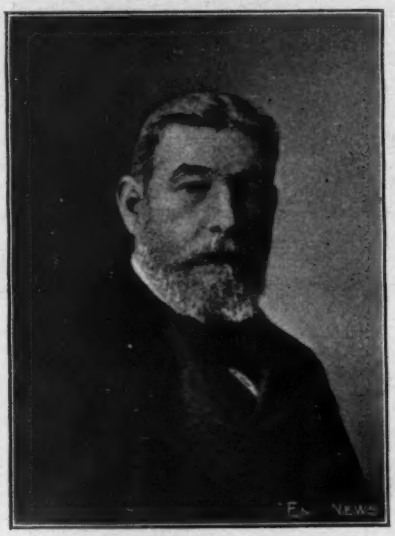
Benjamin Morgan Harrod

On Sept. 7, at his home in New Orleans, La., occurred the death of Benjamin Morgan Harrod, Past-President of the American Society of Civil Engineers, a man who had been in the active practice of his profession since 1859—for more than half a century. During these many years he was connected with numerous great engineering undertakings and was successively a member of two of the most important engineering commissions in the United States, the Mississippi River Commission, 1879 to 1904, and the Isthmian Canal Commission, 1904 to 1907.

Mr. Harrod was born in New Orleans, Feb. 19, 1837, and graduated from Harvard University in 1856. Following his college work he returned to his home in the South and studied engineering, obtaining a position in 1858 as a draftsman and assistant engineer in the United States Lighthouse and Engineers' District, covering a territory extending from the Mississippi River to the Rio Grande. The succeeding year he resigned and entered private practice in New Orleans, where he remained until the outbreak of the Civil War in 1861, when he enlisted in the Confederate Army as a private.

He was rapidly promoted, and having served for a time as First Lieutenant of Artillery, he received a commission as Captain of Engineers, and in this capacity he rendered notable service throughout the war. At the end of the war he again took up his engineering practice in New Orleans and in 1877 received the appointment of State Engineer of Louisiana. The same year he was elected to membership in the American Society of Civil Engineers, of which society he became President in 1897.

In 1879 he resigned his state office to become a member of the Mississippi River Commission, a position which he continued to hold for a quarter of a century. From 1888 to 1892, Mr. Harrod



was City Engineer of New Orleans. From 1895 to 1902 he was Chief Engineer of the Drainage Commission of that city in charge of the great drainage system projected at a cost of $7,000,000.

In the performance of this work Mr. Harrod became the object of bitter public criticism, which caused him to resign and demand an investigation and an expert report upon the work done under his professional control. The Drainage Commission appointed on this board of experts, Messrs. Rudolph Hering, George H. Bensenberg and H. A. Carson, all engineers of national reputation; and the report of this board was an unqualified endorsement, not only of the thoroughness and efficiency of the drainage work as far as executed, but it approved of the course pursued by Mr. Harrod in various departures from the original plans and specifications, the main point of controversy between Mr. Harrod and the then City Engineer, the late L. W. Brown.

Mr. Harrod served as a member of the Isthmian Canal Commission appointed by President Roosevelt on Feb. 29, 1904. The other members of the commission were William H. Burr, C. E. Grunsky, F. T. Hecker, William Barclay Parsons, all prominent civil engineers, Major-General G. W. Davis and Rear-Admiral J. G. Walker, chairman. On Apr. 1, 1905, President Roosevelt appointed a new commission and Mr. Harrod was the only member of the old commission appointed to the new one. It was under this latter commission and its Chief Engineer, John F. Wallace, that the work of digging the canal began in earnest and the organization of the working force was perfected.

Mr. Harrod was a frequent contributor to the *Transactions* of the American Society of Civil Engineers on the subjects of dredging, rainfall, stream flow and concrete. He was the author of a valuable paper on "The Dangers Threatening the Navigation of the Mississippi River and the Reclamation of its Alluvial Lands."

Notes from Engineering Schools

The group shown in the accompanying figure, from the faculties of 25 technical schools in this country, has been entered during the summer on the regular pay roll of the Westinghouse Electric & Manufacturing Co., at East Pittsburgh. The company offered a special course in shop training, to enable instructors in electrical engineering to become familiar with the progress of work through the shop and to see what the students have to do after graduation. The course in-

A GROUP OF ENGINEERING INSTRUCTORS ENGAGED IN SUMMER WORK AT THE WESTINGHOUSE ELECTRIC WORKS

cluded regular shop work and inspection trips after working hours. Regular meetings were held evenings for general discussions and to hear talks by officers of the company. The following men were enrolled: R. M. Berry, Virginia Polytechnic Institute; W. D. Canan, Pennsylvania State College; R. F. Chamberlain, Cornell University; A. T. Childs, University of Maine; Myron Creese, Maryland Agricultural College; F. T. Dargan, Clemsen College; F. B. Davenport, Georgia School of Technology; L. A. Dogett, Harvard University; S. P. Emrick, Purdue University; W. A. Folger, University of Pennsylvania; E. S. Foster, Lehigh University; W. N. Gladson, University of Arkansas; G. W. Grow, University of West Virginia; H. D. Gruber, Lehigh University; W. W. Hill, Alabama Polytechnic Institute; A. P. Kitchen, Massachusetts Institute of Technology; L. W. W. Morrow, Cornell University; M. S. Mason, University of Illinois; E. J. Neary, University of Pennsylvania; A. F. Nesbitt, New Hampshire State College; W. W. Perry, Lafayette College; C. T. Porter, Sheffield Scientific School; V. C. Pritchet, North Carolina A. & M. College; F. A. Robbins, Iowa State College; E. B. Stavely, Columbia University; G. B. Thomas, Colorado College; R. W. Witham, Worcester Polytechnic Institute; B. A. Wooten, Alabama Technical Institute.

A Butting Collision on the Rutland R.R., involving the death of two persons and the injury of 15 to 20, occurred near Bennington, Vt., on Sept. 7.

A Rear Collision in which two persons were killed and six injured, occurred near Latrobe, Penn., on Sept. 10, on the Pennsylvania R.R. A fast passenger train from New York to Chicago drawn by two locomotives struck a helper locomotive, running in the same direction on the same track. A thick fog prevailed at the time.

The Derailment of a fast passenger train on the line of the New York, Chicago & St. Louis R.R. near Erie, Penn., on Sept. 10, caused the serious injury of 28 persons. One of the cars involved in the wreck was the private car of President Canniff of the company, who with other railroad officials escaped injury and assisted in taking care of the injured.

By a Train Derailment near Liverpool, England, on Sept. 17, there were 16 persons killed and about 50 injured. The accident occurred on the line of the London & North Western Ry., and was caused by the derailment of the locomotive, which ran over the ties a short distance and then struck a stone bridge pier. The first two coaches were badly damaged and most of those killed and injured were in these two cars. It is stated that fire followed the wreck.

A Runaway Train on the Pennsylvaani R.R. entered the yards of the Union Station at Harrisburg, Penn., on Sept. 8, and almost reached the station before it could be switched to a side track and derailed. Standing in the station at this time on the regular track of this train, was a passenger train made up largely of sleepers and had the runaway going about 40 miles an hour struck this train there must have been a heavy loss of life. The engineer, who was killed when the train collided with three empty passenger cars on the side track, acknowledged before he died, according to press reports, that he had gone to sleep "for a second" It is also stated that official investigation into the accident shows that the engineer had had 35 hours rest before taking out this train.

Unusually Heavy Rains from Sept. 7-10 destroyed much property in Florida. The city of Tampa suffered porticularly from the resulting floods and the damage is estimated at several hundred thousand dollars.

A Tornado swept through northern New York in the vicinity of Syracuse on Sept. 15 and caused the death of three and the injury of 50 persons, in its path, besides destroying property valued at $250,000.

The Bursting of a Water Turbine on Sept. 13 at Station No. 1 of the Shawinigan Water and Power Co., at Shawinigan Falls, Que., resulted in the drowning of one of the employees, and the flooding of the station.

The Collapse of a Power Plant and mill at Lonsdale, R. I., on Sept. 9, involved a property loss of about $75,000 and threw about 600 employees out of work, pending repairs. The accident occurred at Mill No. 4 of the Lonsdale Co. and is believed to have been brought about by the undermining of the foundations of the water wheel, which has supplied power to the mill for the past thirty or forty years. Repairs had been made to the supports of this wheel about two weeks previous and it was thought to be in good condition.

The failure of a reservoir bottom at Chambersburg, Penn., was reported on Aug. 27. In response to an inquiry we are informed by A. Buchanan, an engineer of Chambersburg, that "two rather small openings in the limestone rock on which the reservoir was built were found by the water. The leaks will be easily remedied."

The Sinking of the G171, a German torpedo boat destroyer, occurred on Sept. 14, near Heligoland, fifteen minutes after it was rammed by the German battleship Zahringen, of 11,500 tons displacement. The G171 was a 616 ton boat, completed at the Germania yards, at Kiel, in 1909. She had a speed of 30 knots an hour and a complement of 75 men, of whom six were lost in the accident.

The Speed Mania made notable additions to the death-roll during the past week. At the Vailsburg Motordrome Stadium in Newark, N. J., on Sept. 8, a motorcyclist traveling 92 miles an hour on a bowl-shaped track lost control of his machine and rode off the track into a crowd of spectators, killing himself, one other cyclist, and six of the spectators, and injuring eighteen others.

At Gray, in the department of Haute-Saone, France, on the same day the opening day of aviation meet, a monoplane traveling at a speed of 40 miles an hour, failed to respond to the control devices and plunged into a crowd of spectators killing four and injuring four others.

The Bureau of Mines Expedition to the Bering River coal fields, in Alaska, was caught in a storm on Controller Bay on Sept. 6, and while all the members of the party and all the horses were saved, the barge, containing the machinery, instruments and other supplies necessary for the work, was lost. It is feared that this accident may delay the work of the expedition for a year because of the time required to obtain a new outfit and also because of the approach of winter.

Of the 42 Amendments to the Ohio constitution voted on at a popular election on Sept. 3, all but eight were carried. On p. 509 of our issue of Sept. 12, a synopsis of those amendments most likely to interest our readers was published, but the vote on each had not been counted at that time. We give below the vote on these amendments, which are here identified by short titles:

	Yes	No
6—Initiative and referendum	312,592	231,312
9—Builders' and mechanics' lien	278,582	242,385
10—Welfare of employes	353,588	189,723
11—Workmen's compensation	321,558	241,772
12—Conservation of natural resources	318,192	191,893
13—Eight-hour day on public works	333,307	232,898
14—Removal of officials	347,333	185,966
17—Abolishing prison contract labor	333,034	215,208
22—Contempt proceedings and injunctions in labor matters	240,896	257,302*
25—Use of voting machines	242,342	288,652*
26—Primary elections	349,801	183,112
29—Fifty million bonds good roads bond limit	272,564	274,502*
31—Abolishing board of public works	296,635	214,829
32—Taxation of bonds, etc.	268,939	249,964
33—Regulation of corporations	300,466	212,704
34—Double liability	377,272	156,688
35—Regulating state printing	319,612	192,388
37—Civil service	306,777	204,580
38—Outdoor advertising regulation	261,351	262,440*
39—Initative on constitutional amendments	271,927	246,687
40—Home rule for cities	301,861	215,120
41—Schedule (enacting clause, etc.)	275,062	213,979

*Amendment lost.

It will be seen that of the eight amendments lost four appear in our list: No. 22, restricting labor injunctions to the protection of physical property, and prohibiting punishment for contempt of court in labor cases without trial by jury; No. 25, authorizing the use of voting machines; No. 29, extending constitutional land limit for inter-county roads to a total of $50,000,000 (others authorized by legislature); and No. 38, which was designed to make constitutional legislation regulating billboard advertising on private property. Less than half the voters went to the polls. The "good roads" amendment was voted down in 48 counties, but came near carrying for all that. All amendments favored by the so called labor element were carried except the No. 22, on labor injunctions and contempt proceedings.

The Alaska Railroad Commission recently appointed by President Taft is authorized by the act creating it "to examine into the transportation question in the Territory of Alaska; to examine railroad routes from the seaboard to the coal fields and to the interior and navigable waterways; to secure surveys and other information with respect to railways; to obtain information with respect to the coal fields and their proximity to railroad routes; and to make report of the facts to Congress, on or before Dec. 1, 1912, together with their conclusions and recommendations with respect to the best and most available routes for railroads in Alaska which will develop the country and its resources for the use of the people of the United States." $25,000 has been appropriated to cover the expenses of the Commission.

Fire Prevention Day is to be celebrated in several of the Western States, on Oct. 9, by a general overhauling and cleaning out of flues and heating devices. This will be the 41st anniversary of the Chicago fire and the celebration of this day, by taking measures to reduce the fire losses, is the result of the efforts of the Western Union, an association organized

for that purpose. Governors Dineen of Illinois, and Carroll of Iowa have issued proclamations urging on the citizens of those states the importance of this work.

Personals

Mr. David H. Ray, Assoc. Am. Soc. C. E., for the past two years Chief Engineer of the Bureau of Buildings, New York City, has resigned to enter private practice as a consulting engineer, with offices at 27 West 33d St., New York City.

Mr. Alfred E. Kornfeld, Assoc. Am. Soc. M. E., until recently Vice-President and Manager of the Engineering News Publishing Co., returned from a four-months' trip in Europe, on Sept. 6. He has taken an office at 41 Park Row, New York City.

Mr. E. J. Mehren, Jun. Am. Soc. C. E., formerly Associate Editor of the "Engineering Record," and recently Secretary and Manager of the Emerson Co., efficiency engineers, New York City, has returned to the staff of the "Engineering Record" as Managing Editor.

Mr. S. R. Hatch, formerly Assistant Manager, has been appointed Acting Manager of the water and light department of Duluth, Minn., succeeding Mr. L. N. Case, resigned. Mr. E. W. Kelly, former Engineer of the department, has been appointed Acting Assistant Manager.

Mr. Alfred Still, Assoc. M. Inst. C. E., has been appointed Chief Electrical Engineer of the mining department of the Algoma Steel Corporation, with headquarters at the Magpie Mine, Ont. Mr. Still was formerly Electrical Engineer of the Lake Superior Power Co., Sault Ste. Marie, Ont.

Mr. Benjamin Franklin, M. Am. Soc. C. E., formerly of Franklin & Clarke, civil engineers, Philadelphia, Penn., announces the formation of the firm of Franklin & Co., in which he is associated with Messrs. A. R. Lindsey, Assoc. M. Am. Soc. C. E., and Wm. H. Gravell, Assoc. Am. Soc. C. E., for the practice of civil and structural engineering, with offices at 906 Crozer Bldg., Philadelphia.

Mr. C. Morton Ayres, M. Am. Soc. C. E., for 11 years Chief Engineer of the Central Iron & Coal Co., and more recently Engineer and Superintendent of the Central Foundry Co., at Holt, Ala., has resigned to enter private practice as a member of the firm of Finnell, Ayres & Parsons, consulting civil and mining engineers and architects, with offices at 12-14 Masonic Temple Bldg., Tuscaloosa, Ala.

Mr. James J. Hill, F. Am. Soc. C. E., former President of the Great Northern Ry., and dean of American railway builders, was the guest of honor at a banquet in commemoration of his 74th birthday, on Sept. 16, at St. Paul, Minn. The banquet was given to Mr. Hill by the citizens of St. Paul and other Northwestern cities. There were 1200 guests present from all parts of the United States.

Mr. Warren E. Hall, Assoc. M. Am. Soc. C. E., of the firm of Hall Bros., civil and mining engineers, Atlanta, Ga., and formerly Division Engineer in the Porto Rico Irrigation Service, has been appointed District Engineer of the U. S. Geological Survey in charge of stream measurements and investigation of water resources in the Southeastern States, succeeding his brother, Mr. M. R. Hall, whose association with the firm of Hall Bros. is noted elsewhere.

Mr. Maxcy R. Hall, for the past 10 years District Engineer of the U. S. Geological Survey, in charge of stream measurements and investigations of water resources in the Southeastern States, has resigned and is now a member of the firm of Hall Bros., civil and mining engineers, Atlanta, Ga. The senior member of this firm is Mr. B. M. Hall, M. Am. Soc. C. E., who was Supervising Engineer in the U. S. Reclamation Service from 1904 to 1907 and Chief Engineer of the Porto Rico Irrigation Service from 1908 to 1910.

Obituary

John O. Potter, for a number of years City Engineer of Muncie, Ind., died Sept. 6. He was 38 years old. He had more recently been a contractor. A widow and three small children survive him.

James D. Schuyler, M. Am. Soc. C. E., one of the most prominent water-supply and irrigation engineers in America, and well known to engineers for his frequent contributions to current technical literature and his book "Reservoirs for Irrigation, Water Power and Domestic Water Supply," died at his home at Santa Monica, Calif., on Sept. 13, following an illness of many months. A biographical sketch of Mr. Schuyler will appear in a later issue.

James Terry Gardiner, of New York City, President of the Mexican Coal & Coke Co., and the Coahuila Coal Ry., in Mexico, formerly a prominent engineer, died at his summer home at Northeast Harbor, Maine, on Sept. 10. Mr. Gardiner was born at Troy, N. Y., and educated at the Rensselaer Polytechnic Institute and Sheffield Scientific School, Yale University, where he received an honorary degree of Ph. B. in 1868. His first engineering work was in Brooklyn, N. Y., as sub-assistant engineer of the Brooklyn water-works. At the beginning of the Civil War he was appointed Inspector in the Ordnance Corps of the United States Army. From 1863 to 1864 he was employed in constructing earthwork defenses in the harbor of San Francisco, Calif. For three years following the close of the war he was Topographical Assistant of the Geological Survey of California, and he later served in the U. S. Geological Survey. Mr. Gardiner was appointed Director of the State Survey of New York in 1876 and continued in this office for 10 years. He was a member of the State Board of Health of New York from 1880 to 1886, and for a number of years following he carried on a private practice as a consulting engineer. From 1892 to 1895 he was President of the Street Railway and Lighting Co., of St. Joseph, Mo., and for a short time was Vice-President of coal companies owned by the Erie R.R.

Engineering Societies

COMING MEETINGS

INTERNATIONAL CONGRESS ON HYGIENE AND DEMOGRAPHY.
Sept. 23-28. Fifteenth congress at Washington, D. C. Secy., John S. Fulton, Senate Annex, Washington, D. C.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
Sept. 24-26. Annual convention at Buffalo, N. Y. Secy., R. D. Moldenke, Watchung, N. J.

CENTRAL STATES WATER WORKS ASSOCIATION.
Sept. 24-26. Annual convention at Detroit, Mich. Secy., R. P. Bricker, Shelby Water Co., Shelby, Ohio.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.
Sept. 25-28. Annual convention at Indianapolis, Ind. Secy., R. C. Harris, City Hall, Toronto, Ont.

NATIONAL IRRIGATION CONGRESS.
Sept. 30-Oct. 3. Annual meeting at Salt Lake City, Utah. Secy., Arthur Hooker, Salt Lake City.

COOPERATIVE SAFETY CONGRESS.
Sept. 30-Oct. 5. Annual convention at Milwaukee, Wis. Chairman, L. R. Palmer, 5852 Douglas Ave., East Pittsburgh, Penn.

AMERICAN ASSOCIATION FOR HIGHWAY IMPROVEMENTS.
Sept. 30-Oct. 5. Annual convention at Atlantic City, N. J. Secy., G. E. Pennybacker, Jr., Colorado Bldg., Washington, D. C.

NATIONAL CONSERVATION CONGRESS.
Oct. 1-4. Annual meeting at Indianapolis, Ind. Secy., Thos. R. Ship, Indianapolis, Ind.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 7-11. Annual convention at Chicago, Ill. Secy., H. C. Donecker, 29 W. 39th St., N. Y. City.

RAILWAY SIGNAL ASSOCIATION.
Oct. 8-11. Annual Convention at Quebec, Canada. Secy., C. C. Rosenberg, Times Bldg., Bethlehem, Penn.

AMERICAN RAILWAY BRIDGE & BUILDING ASSOCIATION.
Oct. 15-17. Annual convention at Baltimore, Md. Secy., C. A. Lichty, 226 Jackson Blvd., Chicago, Ill.

AMERICAN GAS INSTITUTE.
Oct. 16-18. Annual meeting at Atlantic City, N. J. Secy., Geo. G. Ramsdell, 29 West 39th St., New York.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.
Oct. 21-25. Annual meeting at Chicago, Ill. Secy., T. A. Andreucetti, C. & N. W. Ry., Chicago, Ill.

AMERICAN ASSOCIATION FOR THE PREVENTION OF THE POLLUTION OF RIVERS AND WATERWAYS.
Oct. 23-24. Annual convention at Cleveland, Ohio. Secy., H. De B. Parsons, 22 William St., New York.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS
Nov. 12-15. Annual convention at Dallas, Texas. Secy., A. P. Folwell, 50 Union Square, New York.

Central States Water Works Association—The 16th annual convention of the Association will be held at Detroit, Mich., on Sept. 24-26. Most of the papers will be given on Wednesday, Sept. 25, in the forenoon, afternoon and evening sessions. They will deal with various phases of the problems of municipal water supply, touching on rates, sources, purification methods, and fire protection requirements. Details may be obtained from the Association Secretary, R. P. Bricker, whose headquarters are at the Cadillac Hotel, Detroit, Mich.

Cooperative Safety Congress—At the 1st annual convention, at Milwaukee, Wis., Sept. 30-Oct. 5, held under the auspices of The Association of Iron and Steel Electrical Engineers, the following are among the papers to be given: "Advantages to be Derived from the Organization of a Cooperative Safety Society," by L. W. Chaney; "Safety as Standardized by the Inter-State Commerce Commission," by C. C. McCord; "Safety Measures in the Mining Districts of Western Pennsylvania, Ohio, and West Virginia," by H. M. Wilson; "Accidents Attributable to the Carelessness of Employees and How Best to Prevent Them," by A. H. Boyd, Jr.; and "What Labor Organizations are Doing to Encourage Their Men to be More Careful to Guard Against Accidents," by Mr. Boone. An exhibition of all kinds of safety devices will be held in connection with the Congress. Further particulars may be obtained from L. R. Palmer, 5852 Douglas Ave. East End, Pittsburgh, Penn.

Vol.

Fai
th

T
conc
Bou
Lou
30,
bein
This
illus
27.
pro
con

reta
they
was
fro
by
whe
not
ft.
the
fill